S/185/61/006/003/001/010
D208/D302

Passage of a beam...

In the case of quasi-longitudinal propagation, the electron cyclotron frequency and the frequency of the waves are considerably less than Langmuir's frequency. The eigenfrequency of the waves is then given by

$$\omega_0 = \frac{|\omega_H \cos \theta|}{1 + r}, \quad r = \frac{\Omega^2}{k^2c^2} \tag{4.2}$$

The increment is determined by

$$\frac{\varepsilon}{\omega_0} = \frac{-1 + i\sqrt{3}}{2^{4/3}} \left(\frac{\Omega' |\mathrm{ctg}\, \theta|}{\Omega(1+r)} \right)^{2/3} |R|^{1/3}, \tag{4.3}$$

where

$$R = I_s^2 [(u-1)(\sin^2\theta + rus^2) - r\sin^2\theta - r(1+r)\,\mathrm{tg}^2\theta(1-s\sqrt{u})^2 - r^2us^2] + 2ru(\sin^2\theta + r\sqrt{u}s)\,aI_sI_s' + r^2(1+r)ua^2I_s'^2.$$

The dispersion equation is given for waves with frequency $\omega \ll \omega_{Hi}$ (ω_{Hi} being the ion cyclotron frequency). In the case of resonance $\omega_{1,2} \cong k_{\parallel}v_0 + s\omega_{H\alpha}$, the increment is given by

$$\frac{Im\,\varepsilon}{\omega_j} = \frac{\sqrt{3}}{2^{4/3}} \left| \frac{\Omega_\alpha'^2 \omega_{H_\alpha}'^2 \,\mathrm{ctg}^2\theta\, P}{\omega_j^3 Q} \right|^{1/3}. \tag{5.3}$$

Card 6/7

S/185/61/006/003/001/010
D208/D302

Passage of a beam...

$$P = (n^2 - \varepsilon_{11}^{(0)}) s^2 I_s^2 + (n^2 \cos^2 \theta - \varepsilon_{11}^{(0)}) a^2 I_s'^2 - 2i\varepsilon_{12}^{(0)} a s I_s I_s', \quad (5.3)$$

$$Q = \varepsilon_{11}^{(0)} \left[(1 + \cos^2 \theta) \frac{k^2 V_A^2}{\omega_j^2} - 2 + \frac{\omega_j^2}{\omega_{H_i}^2} \right].$$

These equations apply to both ordinary and extraordinary waves. Excitation as well as damping of ion-cyclotron and magnetohydrodynamic waves may occur for all harmonics (s = 0, ±1, ±2,..). There are 7 references: 6 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: D. Bohm, E. Gross, Phys. Rev., 75, 1851, 1864, 1949.

ASSOCIATION: Fizyko-tekhnichnyy instytut AN USSR m. Kharkiv (Physico-Technical Institute AS UkrSSR, Kharkov)

SUBMITTED: September 19, 1960

Card 7/7

26137
S/040/61/025/004/016/021
D274/D306

24.2120

AUTHORS: Stepanov, K.N. and Khomenyuk, V.V. (Khar'kov)

TITLE: Notes on the energy principle in magnetohydrodynamics

PERIODICAL: Prikladnaya matematika i mekhanika, v. 25, no. 4, 1961, 760-763

TEXT: Theorems are proved on the stability of equilibrium states of an ideal conducting fluid, by means of Lyapunov functions. The equations of motion of an ideal, non-viscous, conducting fluid, with small displacements $\xi(r,t)$ from the equilibrium position, are

$$\rho \ddot{\xi}_i = F_i(\xi) \qquad (i = 1,2,3) \tag{1}$$

where F denotes a linear self-conjugated operator

$$F(\xi) = \nabla(\xi . \nabla p) + \gamma \nabla(p \operatorname{div} \xi) + \frac{1}{4\pi} (\operatorname{rot} \operatorname{rot}(\xi \times H) \times H) + \frac{1}{4\pi} \operatorname{rot} H \times \times \operatorname{rot} (\xi \times H)$$

It is assumed that the fluid occupies a finite volume V, bounded by

Card 1/3

26137
S/040/61/025/004/016/021
D274/D306

S, and that the density ρ and the displacements vanish on S. Eq. (1) has the energy integral

$$E = T + U = \text{const} \quad (2)$$

where

$$T\{\dot{\xi}\} = \frac{1}{2}\int_V \rho\dot{\xi}^2 dr, \qquad U\{\xi\} = -\frac{1}{2}\int_V \xi\, F(\xi)\, dr \quad (3)$$

Let ξ and $\dot{\xi}$ be solutions of Eq. (1), satisfying the initial conditions $\xi = \xi_0(r)$, $\dot{\xi} = \dot{\xi}_0(r)$ for $t = 0$

Further, stability, asymptotic stability, and instability are defined. Thereupon, theorem 1, (the necessary condition for stability) is formulated: In order that the equilibrium state $\xi = 0$, $\dot{\xi} = 0$ be stable, it is necessary that $U(\xi) \geq 0$. The theorem is proved by reductio ad absurdum. It follows from the theorem that if there are ξ's for which $U(\xi(r)) < 0$, then the considered equilibrium is unstable. It can be readily shown that the equilibrium state of an ideal non-viscous conducting fluid cannot be asymptotically stable. Further, the effect of viscosity on stability is investigated.

25137
S/040/61/025/004/016/021
D274/D306

Theorem 2. If there us such a $\xi(r)$ so that $U(\xi(r)) < 0$, then the equilibrium is unstable even in the presence of viscous forces. Again, the theorem is proved by an assumption leading to a contradiction. Theorem 2 is analogous to Kelvin's theorem on the effect of dissipation on stability of a system of material points. The functionals involved in the proof of both theorems are analogous to the Lyapunov functions used by N.G. Chetayev in his proof of stability theorems (Ref. 5: Ustoychivost' dvizheniya (Stability of Motion) Gostekhteorizdat, M., 1955). There are 11 references: 6 Soviet-bloc and 5 non-Soviet-bloc. The references to the English-language publications read as follows: S. Lundquist, On the Stability of Magneto-hydrodynamics. Ark. Fys. 1952, v. 5, no. 15; I.B. Bernstein, E.A. Friedman, M.D. Kruskal, R.M. Kulsrud, An energy principle for hydromagnetic stability problems. Proc. Roy. Soc., 1958, v. A244, no. 1236; A. Hare, The effect of viscosity on the stability of incompressible magnetohydrodynamic systems. Phil. Mag., 1959, v. 4, no. 48.

SUBMITTED: January 28, 1961

Card 3/3

S/057/61/031/002/002/015
B124/B204

26.2311
24.2120 (1482, 1502, 1160)

AUTHORS: Stepanov, K. N. and Kitsenko, A. B.

TITLE: The excitation of electromagnetic waves in a magnetically active plasma by means of a beam of charged particles

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 2, 1961, 167-175

TEXT: Electromagnetic waves in an infinite plasma with a beam of non-relativistic particles passing through the plasma parallel to the external magnetic field are dealt with. The growth increments γ of the waves were determined for the case in which the thermal motion of the plasma particles may be neglected ("cold plasma") and in which the density of a passing beam is smaller than that of the plasma. The plasma may be considered to be "cold", if 1) the phase velocity of the waves is much greater than the mean thermal velocity of the plasma particles, 2) the mean Larmor radius of the plasma particles is small compared to the wave length, and 3) the wave frequency is not near the gyrofrequency of the plasma particles. The beam can be considered to be "cold" only when the growth increment is considerably

X

Card 1/9

89156

X

S/057/61/031/002/002/015
B124/B204

The excitation of electromagnetic ...

greater than $\vec{k}v_t$ ($\vec{k}$ is the wave vector, v_t is the mean thermal velocity of the beam particles). For beams with low density, the increment is low and therefore the thermal motion of the particles of the beam is essential also at low beam temperatures. Here, the temperature of the "cold plasma" may be higher than that of the "hot" beam. First, oscillation of the unbounded plasma, through which a beam of charged particles passes parallel to the external magnetic field ($\vec{H}_o$) is dealt with. It is assumed that the volume charge and the electric current of the beam are compensated. In this case a dispersion equation for electromagnetic waves in the plasma in the presence of a beam is obtained on the condition that all quantities $\exp[i(\vec{k}\vec{r}-\omega t)]$ are proportional, from the kinetic equations of the plasma particles and the beam and from the Maxwell equations (see also e.g. Ref. 10):

Card 2/9

S/057/61/031/002/002/015
B124/B204

The excitation of electromagnetic ...

$$An^4+Bn^2+C=0, \tag{2, 1}$$

$$\left.\begin{aligned} A&=\varepsilon_{11}\sin^2\theta+\varepsilon_{33}\cos^2\theta+2\varepsilon_{13}\cos\theta\sin\theta,\\ B&=2(\varepsilon_{12}\varepsilon_{23}-\varepsilon_{22}\varepsilon_{13})\cos\theta\sin\theta+\varepsilon_{13}^2-\varepsilon_{11}\varepsilon_{33}-\\ &-(\varepsilon_{22}\varepsilon_{33}+\varepsilon_{23}^2)\cos^2\theta-(\varepsilon_{11}\varepsilon_{22}+\varepsilon_{12}^2)\sin^2\theta,\\ C&=\varepsilon_{33}(\varepsilon_{11}\varepsilon_{22}+\varepsilon_{12}^2)+\varepsilon_{11}\varepsilon_{23}^2+2\varepsilon_{12}\varepsilon_{23}\varepsilon_{13}-\varepsilon_{22}\varepsilon_{13}^2, \end{aligned}\right\} \tag{2, 2}$$

where ε_{ij} is the tensor of the dielectric constant, $n = kc/\omega$ and Θ the angle between $\vec{k}$ and $\vec{H}_0$. The z axis is parallel to $\vec{H}_0$, the x axis lies in the plain of $\vec{k}$ and $\vec{H}_0$, $k_1 = k_\perp = \sin\Theta k$, $k_2 = 0$, $k_3 = k_\parallel = \cos\Theta k$. The tensor of the dielectric constant has the shape

Card 3/9

89156

S/057/61/031/002/002/015
B124/B204

The excitation of electromagnetic ...

a)

$$\left.\begin{aligned}\varepsilon_{11} &= 1 - \sum_{\alpha} \frac{2\pi\Omega_{\alpha}^{2}}{\omega\omega_{H\alpha}} \sum_{s=-\infty}^{\infty} \int v_{\perp}^{2} dv_{\perp} dv_{\parallel} \frac{R_{\alpha} s^{2} J_{s}^{2}}{a^{2}(s+b)}, \\ \varepsilon_{22} &= 1 - \sum_{\alpha} \frac{2\pi\Omega_{\alpha}^{2}}{\omega\omega_{H\alpha}} \sum_{s=-\infty}^{\infty} \int v_{\perp}^{2} dv_{\perp} dv_{\parallel} \frac{R_{\alpha} J_{s}'^{2}}{s+b},\end{aligned}\right\} \quad (2.9)$$

$$\varepsilon_{33} = 1 - \sum_{\alpha} \frac{\Omega_{\alpha}^{2}}{\omega^{2}} \left(1 + 2\pi \int dv_{\perp} v_{\parallel}^{2} dv_{\parallel} \frac{\partial f_{0\alpha}}{\partial v_{\perp}} + \sum_{s=-\infty}^{\infty} \frac{2\pi\omega}{\omega_{H\alpha}} \int dv_{\perp} v_{\parallel}^{2} dv_{\parallel} \frac{R_{\alpha} J_{s}^{2}}{s+b} \right),$$

$$\varepsilon_{12} = - \sum_{\alpha} \frac{2\pi i \Omega_{\alpha}^{2}}{\omega\omega_{H\alpha}} \sum_{s=-\infty}^{\infty} \int v_{\perp}^{2} dv_{\perp} dv_{\parallel} \frac{R_{\alpha} s J_{s} J_{s}'}{a(s+b)},$$

Card 4/9

89156

S/057/61/031/002/002/015
B124/B204

The excitation of electromagnetic ...

$$\varepsilon_{13} = -\sum_{\alpha} \frac{2\pi\Omega_\alpha^2}{\omega\omega_{H\alpha}} \sum_{s=-\infty}^{\infty} \int v_\perp dv_\perp v_\parallel dv_\parallel \frac{R_\alpha s J_s^2}{a(s+b)},$$

$$\varepsilon_{23} = \sum_{\alpha} \frac{2\pi\Omega_\alpha^2 i}{\omega\omega_{H\alpha}} \sum_{s=-\infty}^{\infty} \int v_\perp dv_\perp v_\parallel dv_\parallel \frac{R_\alpha J_s J_s'}{s+b}, \qquad (2,3)$$

$$\Omega_\alpha^2 = \frac{4\pi e^2 n_{0\alpha}}{m_\alpha}, \quad \omega_{H\alpha} = \frac{e_\alpha H_0}{m_\alpha c}, \quad a = \frac{k_\perp v_\perp}{\omega_{H\alpha}}, \quad b = \frac{k_\parallel v_\parallel - \omega}{\omega_{H\alpha}},$$

$$R_\alpha = \frac{\omega_{H\alpha}}{\omega}\left(-b\frac{\partial f_{0\alpha}}{\partial v_\perp} + \mathrm{ctg}\,\theta a \frac{\partial f_{0\alpha}}{\partial v_\parallel}\right),$$

$J_s = J_s(a)$ is a Bessel function, $J_s' = J_s'(a)$ is its derivative, $n_{0\alpha}$ and $f_{0\alpha}$ are the density and equilibrium function of the distribution of the particles of the kind α. The functions $f_{0\alpha}$ depend on $v_\perp$ and $v_\parallel$ ($v_\perp$ and $v_\parallel$ are the components of particle velocity which are perpendicular and/or parallel to H_0. The summation in (2.3) is carried out over all kinds of beam particles

Card 5/9

The excitation of electromagnetic ...

in the plasma. The integration of a $v_{\parallel}$ is from $-\infty$ to $+\infty$. Eq. (2.3) may be obtained also when using the general equation for ε_{ij} (obtained by V. D. Shafranov). The tensor ε_{ij} is represented in the form $\varepsilon_{ij} = \varepsilon_{ij}^{(0)} + \varepsilon'_{ij}$ (2.4), where $\varepsilon_{ij}^{(0)}$ denotes the tensor of the dielectric constant of the "cold" plasma, whose components are given by (2.5):

$$\varepsilon_{11}^{(0)} = \varepsilon_{22}^{(0)} = 1 - \sum_{\alpha} \frac{\Omega_{\alpha}^2}{\omega^2 - \omega_{H\alpha}^2}, \quad \varepsilon_{33}^{(0)} = 1 - \sum_{\alpha} \frac{\Omega_{\alpha}^2}{\omega^2},$$

$$\varepsilon_{12}^{(0)} = - \sum_{\alpha} \frac{i\Omega_{\alpha}^2 \omega_{H\alpha}}{\omega(\omega^2 - \omega_{H\alpha}^2)}, \quad \varepsilon_{13}^{(0)} = \varepsilon_{23}^{(0)} = 0. \qquad (2,5)$$

The summand ε'_{ij} is due to the presence of the beam. Should the inequalities $k_{\parallel}^2 (v_{\parallel} - v_0)^2 \ll (\omega - s\omega_{H\alpha} - k_{\parallel} v_0)^2$ and $k_{\perp} v_{\perp} \ll |\omega_{H\alpha}|$ hold, if $v_0 = \bar{v}_{\parallel}$ is the drift velocity of the beam, the thermal motion of the particles need not be taken into account, where (2.6)

Card 6/9

89156
S/057/61/031/002/002/015
B124/B204

$$\left.\begin{aligned}
\varepsilon'_{11} &= \varepsilon'_{22} = -\sum_{\alpha} \frac{\Omega_{\alpha}'^{2}(\omega - k_{\parallel}v_0)^2}{\omega^2\left[(\omega - k_{\parallel}v_0)^2 - \omega_{H\alpha}'^{2}\right]}, \\
\varepsilon'_{33} &= -\sum_{\alpha} \frac{\Omega_{\alpha}'^{2}}{\omega^2}\left[\frac{\omega^2}{(\omega - k_{\parallel}v_0)^2} + \frac{(k_{\perp}v_0)^2}{(\omega - k_{\parallel}v_0)^2 - \omega_{H\alpha}'^{2}}\right], \\
\varepsilon'_{12} &= -\sum_{\alpha} \frac{i\Omega_{\alpha}'^{2}(\omega - k_{\parallel}v_0)\,\omega'_{H\alpha}}{\omega^2\left[(\omega - k_{\parallel}v_0)^2 - \omega_{H\alpha}'^{2}\right]}, \\
\varepsilon'_{13} &= -\sum_{\alpha} \frac{\Omega_{\alpha}'^{2}(\omega - k_{\parallel}v_0)\,k_{\perp}v_0}{\omega^2\left[(\omega - k_{\parallel}v_0)^2 - \omega_{H\alpha}'^{2}\right]}, \\
\varepsilon'_{23} &= \sum_{\alpha} \frac{i\Omega_{\alpha}'^{2}\omega'_{H\alpha}k_{\perp}v_0}{\omega^2\left[(\omega - k_{\parallel}v_0)^2 - \omega_{H\alpha}'^{2}\right]}.
\end{aligned}\right\} \quad (2,6)$$

and the cross bar denote that the respective quantity refers to the beam. For studying the effect of thermal leakage of the beam particles by excitement of the waves of the plasma, the equilibrium function of the beam

89156

S/057/61/031/002/002/015
B124/B204

The excitation of electromagnetic ...

particle distribution is chosen in the form

$$f_{0\alpha} = \frac{1}{(2\pi)^{3/2} v_{T,\alpha}^3} \exp\left[-\frac{v_\perp^2 + (v_\parallel - v_0)^2}{2 v_{T,\alpha}^2}\right], \quad v_{T,\alpha}^2 = \frac{T_\alpha}{m_\alpha} \tag{2.7}$$

where the tensor ε'_{ij} assumes the form

$$\varepsilon'_{11} = \sum_{\alpha, s} \frac{\Omega'^2_\alpha}{\omega^2} z_0 e^{-\mu} I_s \frac{s^2}{\mu} i \sqrt{\pi} w(z_s),$$

$$\varepsilon'_{22} = \sum_{\alpha, s} \frac{\Omega'^2_\alpha}{\omega^2} z_0 e^{-\mu} \left[\left(\frac{s^2}{\mu} + 2\mu\right) I_s - 2\mu I'_s\right] i \sqrt{\pi} w(z_s),$$

$$\varepsilon'_{33} = \sum_{\alpha} \frac{2\Omega'^2_\alpha}{\omega^2} \left[y_0^2 + \sum_s z_0 e^{-\mu} I_s y_s^2 i \sqrt{\pi} w(z_s)\right],$$

$$\varepsilon'_{12} = \sum_{\alpha, s} \frac{\Omega'^2_\alpha}{\omega^2} z_0 e^{-\mu} s (I_s - I'_s) \sqrt{\pi} w(z_s),$$

$$\varepsilon'_{13} = \sum_{\alpha, s} \frac{\Omega'^2_\alpha}{\omega^2} z_0 e^{-\mu} I_s \frac{s y_s}{\sqrt{\mu}} i \sqrt{2\pi} w(z_s),$$

$$\varepsilon'_{23} = \sum_{\alpha, s} \frac{\Omega'^2_\alpha}{\omega^2} z_0 e^{-\mu} \sqrt{\mu} (I'_s - I_s) y_s \sqrt{2\pi} w(z_s),$$

2.8

Card 8/9

where $I_s = I_s(\mu)$ is a modified Bessel function, $I'_s = dI_s/d\mu$, $\sqrt{\mu} = k_{\perp} v_{h.n}/\omega'_{H\alpha}$, $z_s = (\omega - s\omega'_H - k_{\parallel} v_0)/\sqrt{2} k_{\parallel} v_{h\alpha}$, $y_s = (\omega - s\omega'_{H\alpha})/\sqrt{2} k_{\parallel} v_{h\alpha}$, and $w(z_s)$ is the probability integral. In the further course of the work, equations are derived for the electron longitudinal oscillations, the quasi-longitudinal propagation as well as the ion-cyclotron and magnetohydrodynamic waves. Mention is made of A. I. Akhivezer, V. V. Zheleznyakov, Ya. B. Faynberg, and V. P. Dokuchayev. A. I. Akhiyezer and V. F. Aleksin are thanked for discussion and valuable advice. There are 12 references: 10 Soviet-bloc and 2 non-Soviet-bloc.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN USSR, Khar'kov (Institute of Physics and Technology AS UkrSSR, Khar'kov)

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SUBMITTED: May 9, 1960

S/057/61/031/002/003/015
B020/B067

26.2330
24.2120 (1482, 1502, 1160)

AUTHORS: Kitsenko, A. B. and Stepanov, K. N.

TITLE: Cyclotron instability in plasma

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 2, 1961, 176-179

TEXT: It is known that the anisotropy of the equilibrium distribution of plasma electrons and ions with respect to velocity may lead to instabilities. The present paper deals with the instability of an unbounded plasma in a homogeneous magnetic field H_o if ions with an equilibrium distribution function of the form (1)

$$z_s = \frac{\omega_j - k_{\parallel} v_0 + s|\omega_{H_i}|}{}.$$

occur in the plasma, where n_o the density of the ions, $v_{\perp}$ and $v_{\parallel}$ the perpendicular and parallel components, respectively, of the ion velocity. The ions with the distribution function (1) have the same Larmor radius $r_o = v_o/\omega_H$, where $\omega_H = eH_o/Mc$ and M the mass of the ion. It is demonstrated

Card 1/8

89157

S/057/61/031/002/003/015
B020/B067

Cyclotron instability in plasma

that disturbances of a wavelength of the order of r_0 and frequencies which are equal to or a multiple of the gyrofrequency ω_H are unstable (cyclotron instability). The order of magnitude of the growth increment is equal for the first harmonics. It may be expected that the results obtained for an unbounded plasma will be qualitatively also correct for adiabatic traps. First, the case is studied where the thermal scattering of ion velocities parallel to H_0 can be neglected. Hence, it may be assumed that $f_0(v_{\parallel}) = f(v_{\perp})$. The tensor of the dielectric constant in this case has form (2),

$$\left.\begin{aligned} \varepsilon_{11} &= -\frac{\Omega^2}{\omega'^2}\left[1 + \sum_{n=-\infty}^{\infty}\left(\frac{2\omega_{H} n^3 J_n J_n'}{(\omega' - n\omega_{H})\,a} + \frac{\operatorname{ctg}^2\theta\,\omega_{H}^2 n^2 J_n^2}{(\omega' - n\omega_{H})^2}\right)\right], \\ \varepsilon_{22} &= -\frac{\Omega^2}{\omega'^2}\left[1 + \sum_{n=-\infty}^{\infty}\left(\frac{\omega_{H} n \left(a^2 J_n'^2\right)'}{(\omega' - n\omega_{H})\,a} + \frac{\operatorname{ctg}^2\theta\,\omega_{H}^2 n^2 J_n'^2}{(\omega' - n\omega_{H})^2}\right)\right]. \end{aligned}\right\} \tag{2}$$

4)

Card 2/8

89157

S/057/61/031/002/003/015
B020/B067

Cyclotron instability in plasma

$$\left.\begin{aligned}
\varepsilon_{33} &= \varepsilon_{33}^{(e)} - \frac{\Omega^2}{\omega'^2}, \\
\varepsilon_{12} &= -i\frac{\Omega^2}{\omega'^2}\sum_{n=-\infty}^{\infty}\left(\frac{\omega_H n^2 (aJ_n J_n')'}{(\omega' - n\omega_H)a} + \frac{\mathrm{ctg}^2\theta\,\omega_H^2 a n J_n J_n'}{(\omega' - n\omega_H)^2}\right) - \frac{i\Omega^2}{\omega'\omega_H}, \\
\varepsilon_{13} &= -\frac{\Omega^2}{\omega'^2}\sum_{n=-\infty}^{\infty}\frac{\mathrm{ctg}\,\theta\,\omega_H n J_n^2}{\omega' - n\omega_H}, \\
\varepsilon_{23} &= i\frac{\Omega^2}{\omega'^2}\sum_{n=-\infty}^{\infty}\frac{\mathrm{ctg}\,\theta\,\omega_H a J_n J_n'}{\omega' - n\omega_H}.
\end{aligned}\right\} \quad (2)$$

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where $\Omega = (4\pi e^2 n_o/M)^{1/2}$ the Langmuir ion frequency, θ the angle between the wave vector $\vec{k}$ and $\vec{H}_o$; $k_\parallel = k\cos\theta$; $k_\perp = k\sin\theta$; $a = k_\perp r_o$; $I_n = I_n(a)$ a Bessel function; the prime denotes the differentiation with respect to a; $\omega' = \omega \mp i\gamma$ is the complex frequency. The axis 03 is parallel to $\vec{H}_o$, the axis 01 lies in the plane of the vectors $\vec{k}$ and $\vec{H}_o$. If the electrons have

Card 3/8

89157
S/057/61/031/002/003/015
B020/B067

Cyclotron instability in plasma

Maxwellian velocity distribution, (3) holds

$$\left.\begin{aligned} \varepsilon_{33}^{(e)} &= \frac{\Omega_e^2}{k_\parallel^2 v_e^2}\left[1 + i\sqrt{\pi}\, w(z_e)\right], \quad v_e^2 = \frac{T_e}{m}, \\ w(z_e) &= e^{-z_e^2}\left(\frac{-k_\parallel}{|k_\parallel|} + \frac{2i}{\sqrt{\pi}}\int_0^{z_e} e^{t^2}dt\right), \quad z_e = \frac{\omega'}{\sqrt{2}\, k_\parallel v_e}, \end{aligned}\right\} \quad (3)$$

where Ω_e the Langmuir electron frequency. The solutions are then obtained for the dispersion relations for electromagnetic waves near $\omega_s = s\omega_H$ in the plasma (Ref. 1):

$$\omega' = \omega_s + \varepsilon, \ |\varepsilon| \ll \omega_H, \ s = 0, \pm 1, \pm 2, \quad (4).$$

If the quantity $a = k_\perp r_0$ is not too low and the number of the harmonics s not too high, the last summands for ε_{ij} in equation (2) $\sim 1/(\omega' - s\omega_H)^2$ are the highest. Taking account of this fact

$$\varepsilon^2 = -\frac{\Omega^2\omega_H^2}{k_\perp^2 c^2}\left(s^2 J_s^2 + \cos^2\theta\, a^2 J_s'^2\right) + \frac{\Omega^2 k_\parallel^2 v_e^2 J_s^2}{\Omega_e^2\left[1 + i\sqrt{\pi}\, z_e w(z_e)\right]}, \quad (5)$$

Card 4/8

89157
S/057/61/031/002/003/015
B020/B067

holds, where $z_e = \omega_s/\sqrt{2}\, k_{\parallel} v_e$. If $a \sim 1$, $|z_e| \sim v_0/v_e$. If it appears from (5) that $\gamma = \mathrm{Im}\,\omega > 0$, the plasma is unstable. This is always the case when the first summand in (5) is greater than the second one, and also for $|z_e| \gg 1$, if (6).

$$\gamma^2 \approx -\varepsilon^2 = \frac{\Omega^2 \omega_H^2}{k_\perp^4 c^2}\left(s^2 J_s^2 + \cos^2\vartheta\, a^2 J_s'^2\right) + \frac{\Omega^2 \omega_s^2 J_s^2}{\Omega_e^2}.$$

Finallly the case is dealt with where the thermal motion of the ions is essential. For reasons of simplicity, function $f_0(v_\parallel)$ is assumed to be of Maxwellian type, i.e., (7)

$$f_0(v_\parallel) = \frac{1}{\sqrt{2\pi}\, v_i} \exp\left(-\frac{v_\parallel^2}{2 v_i^2}\right), \quad v_i^2 = \frac{T_i}{M}.$$

Cyclotron instability in plasma

In this case, the tensor ε_{ij} is determined by equations (8),

$$\left.\begin{aligned}
\varepsilon_{11} &= -\frac{\Omega^2}{\omega'^2}\left[1-\frac{a^2}{2\mu}-\sum_{n=-\infty}^{\infty} i\sqrt{\pi}\,w(z_n)\left(\frac{z_n}{\mu}n^2J_n^2+2n^3J_nJ_n'\frac{z_0\omega_H}{a\omega'}\right)\right],\\
\varepsilon_{22} &= -\frac{\Omega^2}{\omega'^2}\left[1-\frac{a^2}{2\mu}-\sum_{n=-\infty}^{\infty} i\sqrt{\pi}\,w(z_n)\left(\frac{a^2z_n}{\mu}J_n'^2+\frac{n\omega_H z_0}{a\omega'}\left(a^2J_n'^2\right)'\right)\right],\\
\varepsilon_{33} &= \varepsilon_{33}^{(e)}+\frac{\Omega^2}{\omega'^2}\left[2z_0^2+\frac{a^2\,\mathrm{tg}^2\,\theta}{2\mu}+\mathrm{tg}^2\theta+\right.\\
&\left.\quad+\sum_{n=-\infty}^{\infty} 2i\sqrt{\pi}\,z_n^2w(z_n)\left(z_nJ_n^2+\frac{2\mu z_0\omega_H}{a\omega'}nJ_nJ_n'\right)\right];\\
\varepsilon_{12} &= -\frac{\Omega}{\omega'^2}\sum_{n=-\infty}^{\infty}\sqrt{\pi}\,w(z_n)\left[\frac{z_0n^2\omega_H}{a\omega'}(aJ_nJ_n')+\frac{z_n}{\mu}naJ_nJ_n'\right]-\frac{i\Omega^2}{\omega\omega_H},\\
\varepsilon_{13} &= \frac{\Omega^2}{\omega'^2}\,\mathrm{tg}\,\theta\left[1-\frac{n^2}{2\mu}+\sum_{n=-\infty}^{\infty} i\sqrt{\pi}\,z_nw(z_n)\left(\frac{2n^2J_nJ_n'}{a}+\frac{z_nn\omega'}{z_0\mu\omega_H}J_n^2\right)\right],\\
\varepsilon_{23} &= \frac{\Omega^2}{\omega'^2}\sum_{n=-\infty}^{\infty}\mathrm{tg}\,\theta\,z_nw(z_n)\left[\frac{n}{a}(aJ_nJ_n')'+\frac{az_n\omega'}{\mu z_0\omega_H}J_nJ_n'\right],
\end{aligned}\right\}\quad (8)$$

Card 6/8

89157

S/057/61/031/002/003/015
B020/B067

Cyclotron instability in plasma

where $z_n = (\omega' - n\omega_H)/\sqrt{2}\, k_{\parallel} v_i$, $\mu = (k_{\perp} v_i/\omega_H)^2$. With $T_i \rightarrow 0$ the equations (8) go over into equations (2). The equations (5) and (6) for ε and γ are correct if $|z_s| \gg 1$, i.e., $\gamma \gg kv_i$. If $|z_n| \gg 1$ with $n \neq s$ and $|z_s| \ll 1$, the wave vector $k = k_{1,2}$ corresponds to the frequency $\omega = \omega_s$ ($k_{1,2}$ denotes the solution of equations (9) and (10). $\frac{s^2 J_s^2}{a^4} = \left(\frac{\cos\theta v_i V_A}{\sin\theta v_0^2}\right)^2$,

$$\frac{J_s'^2}{a^4} = \left(\frac{v_i V_A}{\sin\theta v_0^2}\right)^2.$$

If k differs only slightly from k_1 and k_2, $\omega' = \omega_s \mp \delta_{1,2}$, where (11) and (12).

$$\gamma_1 = \sqrt{\frac{2}{\pi}} \frac{|k_{\parallel}| v_0^4 s^2 \sin^2\theta}{v_i V_A^2 \cos^2\theta} \left(\frac{J_s^2}{a^4}\right)' \delta a_1, \quad (11)$$

$$\gamma_2 = \sqrt{\frac{2}{\pi}} \frac{|k_{\parallel}| v_0^4 \sin^2\theta}{v_i V_A^2} \left(\frac{J_s'^2}{a^4}\right)' \delta a_2, \quad (12)$$

$$\delta a_{1,2} = \frac{(k - k_{1,2}) \sin\theta v_0}{\omega_H}.$$

Card 7/8

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B020/B067

Cyclotron instability in plasma

The authors studied the occurrence of the instability for frequencies near ω_s. As may be seen from (5), the growth increment is small compared with the frequency if $v_0 \ll V_A$. For high-density plasmas, where $\Omega \gg \omega_H$, stronger instabilities occur in the case of disturbances with a wavelength of the order of r_0, for which growth frequency and increment are in the order of ω_H. In this case ω and γ can be determined only numerically.

There is 1 Soviet-bloc reference.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN USSR, Khar'kov (Institute of Physics and Technology of the AS UkrSSR, Khar'kov)

SUBMITTED: May 9, 1960

Card 8/8

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28770
S/057/61/031/010/003/015
B111/B112

AUTHORS: Pakhomov, V. I., Aleksin, V. F., and Stepanov, K. N.

TITLE: Radiation of an electron moving on helical orbits in a magnetically active plasma. I.

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 10, 1961, 1170 - 1184

TEXT: The determination of the radiation intensity of an electron moving in a magnetic field is significant for thermonuclear reactions, radiophysical and astrophysical problems. Several authors have worked in this field: A. G. Sitenko, A. A. Kolomenskiy (Ref. 1: ZhETF, 30, 511, 1956), A. A. Kolomenskiy (Ref. 2: DAN SSSR, 106, 982, 1956), V. Ya. Eydman (Ref. 5: ZhETF, 34, 131, 1958), V. L. Ginzburg, V. V. Zheleznyakov (Ref. 7: Izv. vuzov, Radiofizika, 1, no. 2, 59, 1959), and B. A. Trubnikov, A. Ye. Bazhanova (Ref. 8: Sb. "Fizika plazmy i problema upravlyayemykh termoyadernykh reaktsiy" - " Plasma physics and the problem of controlled thermonuclear reactions", izd. AN SSSR, v. 3, p. 121, 1958). This article deals with the determination of the energy loss of a non-relativistic electron moving on a helical orbit in plasma. The mean thermal velocity

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Card 1/6

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Radiation of an electron moving on ...

of the electron is much smaller than the velocity of light. The energy absorption due to thermal motion is taken into account. Proceeding from the Maxwell equations and after carrying out a Fourier transformation $\vec{E}(\vec{r},t) = \int \vec{E}(\vec{k},\omega)e^{i\vec{k}\vec{r}-i\omega t} d\vec{k}d\omega$ for an anisotropic plasma dispersed in space and time, the authors derive general formulas for $\vec{E}$ and $\vec{H}$ in spherical coordinates, which are used to calculate the intensity of the magnetic bremsstrahlung of the electron. The following relation holds for the frequency of the s-th harmonic ω_s: $\omega_s = s\omega_H + k_{\parallel} v_{\parallel}$, where $\omega_H = \frac{eH_0}{mC}$; $k_{\parallel}$ and $v_{\parallel}$ are the projections of $\vec{k}$ and $\vec{v}$ onto the direction of the external field. The summand $k_{\parallel} v_{\parallel}$ takes the Doppler shift of the frequency into account. The radiation intensity in the solid angle dO is given by
$\omega(\chi,\varphi,t)\, dO = \frac{c}{4\pi} \sum_{s,s'=-\infty}^{\infty} (E_{\chi s} H_{\varphi s'} - E_{\varphi s} H_{\chi s'}) R^2\, dO$, where $E_{\chi s}$, $E_{\varphi s}$, $H_{\chi s'}$ and $H_{\varphi s'}$ are the Fourier components of E_{χ}, E_{φ}, H_{χ} and H_{φ}, respectively. The magnetic bremsstrahlung of non-relativistic particles in the fundamental frequency in dilute plasma is studied. Since the refractive index

Card 2/6

in this case is close to unity, the general formulas become simpler. The solution of the dispersion equation shows that the attenuation factor of the ordinary wave is considerably lower than that of the extraordinary one. Formulas for E_χ, E_φ, H_χ, and H_φ, which describe outgoing and incoming waves, are given. The following relation is derived for the radiation intensity of the extraordinary wave in the first harmonic:

$$w_2 = \frac{e^2 \omega_H^2 v_\perp^2}{8\pi c^3} (1 + \cos^2\chi)\, e^{-2\varkappa_2 R}, \text{ where}$$

$$\varkappa_2 = \frac{1}{4}\sqrt{\frac{\pi}{2}}\, \frac{\Omega^2 (1 + \cos^2\chi)}{\omega_H \beta c_\perp |\cos\chi|} \cdot \exp\left(-\frac{v_\perp^2}{2v_T^2}\right), \quad \beta = v_T/c.$$

The radiation in higher harmonics for dilute plasmas is calculated as well. The condition $s\beta n_j \ll 1$ (s - number of harmonics; n_j - refractive index for the ordinary wave ($j = 1$) and for the extraordinary wave ($j = 2$)) must be satisfied here. For the radiation intensity of the s-th harmonic in the unit solid angle one obtains

$$w_{sj}(\chi) = \frac{e^2\omega_H^2}{2\pi c}\beta_\perp^{2s} U_{sj}(\theta) e^{-\tau_{sj} R}, \qquad (4,7)$$

where

$$U_{sj}(\theta) = \frac{s^2 \sin^2\theta\,(s n_j \sin\theta)^{2s-2}\cos^2\chi\,\Phi_{sj}(\theta)}{2^{2s}(s!)^2\cos^2\theta\left|\frac{d\cos\chi}{d\theta}\right|\left[n_j^4\sin^4\theta\,(\varepsilon_3-\varepsilon_1)^2 + 4\varepsilon_3\varepsilon_2^2(\varepsilon_3 - n_j^2\sin^2\theta)\right]},$$

$$\Phi_{sj}(\theta) = \left(-n_j^2\sin\theta\frac{dn_j}{d\theta} + \varepsilon_3 n_j\cos\theta + \varepsilon_3\sin\theta\frac{dn_j}{d\theta}\right)\times$$

$$\times(n_j^2-\varepsilon_1-\varepsilon_2)^2\varepsilon_2\cos\theta + n_j\left[\varepsilon_3 n_j^2\cos^2\theta + (\varepsilon_1+\varepsilon_2)(n_j^2\sin^2\theta - \varepsilon_3)\right]^2,$$

$$\frac{dn_j}{d\theta} = \frac{uv\sin\theta\cos\theta\, n_j(n_j^2-1)}{2(1-u-v+uv\cos^2\theta)n_j^2 + (2-v)u - 2(1-v)^2 - uv\cos^2\theta}. \qquad (4,8)$$

Although for a low density $n_j \sim 1$, the angular distribution of the radiation intensity of a single electron in the first harmonics differs considerably from that into the vacuum. The emissivity and absorptivity of a plasma for frequencies near $s\,\omega_H$ are given by

Card 4/6

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Radiation of an electron moving on ...

$$\eta_j(\omega) = \frac{\pi n e^2 \omega_0}{2\pi\sqrt{2\pi}\, c n_j \cos\theta} \beta^{2s-1} 2^s s!\, U_{sj}(0) e^{-z_s^2}, \qquad z_s = \frac{\omega - s\omega_\parallel}{\sqrt{2}\,\omega\beta n_j \cos\theta}. \quad (4.16) \text{ (emission)},$$

$\alpha_j(\omega_s) = 2\varkappa_{sj}$ (absorption), where $\varkappa_j = k'_{\parallel j}(k_{\perp j})\cos\chi$ and $\varkappa_{sj}$ are the corresponding Fourier components. A. I. Akhiyezer is thanked for advice. S. M. Rytov (Ref. 13: Teoriya elektricheskikh fluktuatsiy i teplovogo izlucheniya - Theory of electric fluctuations and thermal radiation, Izd. AN SSSR, M., 1953) is mentioned. There are 1 figure and 13 references: 12 Soviet and 1 non-Soviet. The reference to the English-language publication reads as follows: Ref. 4: R. Q. Twiss, J. A. Roberts, Aust. J. Phys., II, no. 3, 424, 1958.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN USSR, Khar'kov (Physico-technical Institute, AS UkrSSR, Khar'kov)

SUBMITTED: January 31, 1961

Card 5/6

25206
S/056/61/040/006/027/031
B125/B202

24.6714

AUTHORS: Akhiyezer, A. I., Kitsenko, A. B., Stepanov, K. N.

TITLE: Interaction between charged particle currents and low-frequency plasma oscillations

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 6, 1961, 1866-1870

TEXT: The authors deal with the interaction between a compensated beam of charged particles and the low-frequency oscillations of a plasma (mainly with the magneto-acoustic waves and the Alfvèn waves) in a constant field in parallel direction to the beam and in the absence of collisions. If the plasma is rarefied to such an extent that the frequency ω of the oscillations is much higher than the frequency $1/\tau$ of the collisions, the plasma oscillations must be described on the basis of the kinetic equation. With $\omega\tau \ll 1$ the plasma can be described hydrodynamically. The authors studied the case $\omega\tau \gg 1$. The general dispersion equation for plasma oscillations in an external magnetic field with random distribution function of the particles with respect to the velocities

Card 1/7

25206

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Interaction between charged ...

reads as follows: $An^4 + Bn^2 + C = 0$ (1) where $n = kc/\omega$. The wave vector $\vec{K}$ and the quantities A, B, and C are determined by the components of the tensor of the dielectric constant ε_{ij}. Furthermore, it is assumed that $\omega \ll \omega_{Hi}$, $kv_o \ll \omega_{Hi}$ where ω_{Hi} is the gyrofrequency of the ions, $v_i = (T_i/M)^{1/2}$ the mean thermal velocity of the ions (T_i denotes the temperature and M the mass of the ions) and v_o the velocity of the beam. Under these conditions (1) falls into the equations $(kc/\omega)^2\cos^2\theta - \varepsilon_{11} = 0$ (3) and $(kc/\omega)^2 - \varepsilon_{22} - \varepsilon_{23}^2/\varepsilon_{33} = 0$ (4) describing the Alfvèn wave and the sound wave, respectively. If the velocity distribution of the particles in the beam has the form $f_{e,i} = n_0'\left(\frac{m_{e,i}}{2\pi T'_{e,i}}\right)^{3/2}\exp\left\{-\frac{m_{e,i}(v-v_0)^2}{2T'_{e,i}}\right\}$ (5)

(n_o' density of the particles in the beam, T_e', T_i' temperatures of the electrons and ions of the beam, $m_e = m$, $m_i = M$)

Card 2/7

$$\varepsilon_{11} = 1 + \sum_\alpha \frac{\Omega_\alpha^2 (\omega - k_\parallel v_{0\alpha})^2}{\omega_{H\alpha}^2 \omega^2}, \quad \varepsilon_{22} = \varepsilon_{11} + \sum_\alpha \frac{\Omega_\alpha^2 k^2 v_\alpha^2}{\omega_{H\alpha}^2 \omega^2} 2i\sqrt{\pi} \sin^2\theta z_\alpha w(z_\alpha),$$

$$\varepsilon_{33} = 1 + \sum_\alpha \frac{\Omega_\alpha^2}{k_\parallel^2 v_\alpha^2} (1 + i\sqrt{\pi} z_\alpha w(z_\alpha)),$$

$$\varepsilon_{23} = -\sum_\alpha \frac{\Omega_\alpha^2}{\omega \omega_{H\alpha}} \sqrt{\pi} \operatorname{tg}\theta z_\alpha w(z_\alpha), \qquad (6)$$

где

$$w(z_\alpha) = e^{-z_\alpha^2}\left(\pm 1 + \frac{2i}{\sqrt{\pi}} \int_0^{z_\alpha} e^{t^2} dt\right), \quad z_\alpha = \frac{\omega - k_\parallel v_{0\alpha}}{\sqrt{2} k_\parallel v_\alpha},$$

$$\Omega_\alpha^2 = 4\pi e^2 n_{0\alpha}/m_\alpha, \quad v_\alpha^2 = T_\alpha/m_\alpha, \quad \omega_{H\alpha} = e_\alpha H_0/m_\alpha c, \quad k_\parallel = k\cos\theta$$

holds with Maxwellian equilibrium velocity distribution of the electrons and ions of the plasma. The upper and lower signs in $\omega(z_\alpha)$ hold with $k_\parallel > 0$ and $k_\parallel < 0$, respectively; the index α denotes the types of all particles of the plasma and the beam. With the aid of (6) expression

$$\omega = k_\parallel \frac{v_0 \Omega_i'^2 \pm [(\Omega_i^2 + \Omega_i'^2) c^2 \omega_{Hi}^2 - \Omega_i^2 \Omega_i'^2 v_0^2]^{1/2}}{\Omega_i^2 + \Omega_i'^2}. \qquad (7)$$

25206
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for the frequency of the Alfvèn wave modified by the existence of the beam is obtained from (3). Due to the excitation of the Alfvèn waves the state of the system plasma - beam is unstable if condition

$$v_0^2 > V_A^2 + V_A'^2, \quad (8)$$

где $V_A = H_0/\sqrt{4\pi n_0 M}$, $V'_A = H_0/\sqrt{4\pi n'_0 M}$.

is fulfilled. With sufficiently low densities of the beam the excitation of the Alfvèn waves is impossible as long as the coupling between the Alfvèn waves and the magneto-acoustic waves is neglected. When considering this coupling an instability is observed also with those densities at which (8) is not valid. In the following study of the beam by means of the magneto-acoustic waves the density of the beam is assumed to be small as compared to the plasma density. With $kv_i \ll \omega \ll kv_e$ the solution of the dispersion equation (4) has the form

$$\omega_\pm = kV_\pm, \quad V_\pm^2 = \frac{1}{2}\{V_A^2 + s^2 \pm [(V_A^2 + s^2)^2 - 4V_A^2 s^2 \cos^2\theta]^{1/2}\}, \quad (9)$$

with lacking beam, where $s = (T_e/M)^{1/2}$. With $V_A \sim s$ the quantities $V_\pm$ are also of the order of magnitude s. In this case the condition $\omega \gg kv_i$

holds only for a strongly nonisothermal plasma ($T_e \gg T_i$) while the magneto-acoustic waves with $T_e \lesssim T_i$ are strongly attenuated. Besides, also $|\omega - k_{\parallel} v_o| \gg kv_e'$ holds. The dispersion equation (4) then reads as follows: $\omega = k_{\parallel} v_o + \varepsilon$ (10) with $|\varepsilon| \ll |k_{\parallel} v_o|$. Under the conditions studied, the state of the system plasma-beam is unstable due to the excitation of the magneto-acoustic waves. If v_o does not lie in the interval $s < v_o < V_A$ this instability occurs even with neglection of η_i ($|\eta| \ll 1$). With $v_o \cos\theta \to V_{\pm}$, (13) holds. With the maximum (resonance) interaction (with $V_{\pm} = v_o \cos\theta$) the increment of increase of the oscillations is not proportional to $(n_o'/n_o)^{1/2}$ but to $(n_o'/n_o)^{1/3}$. The solutions (10) to (13) of the dispersion equation (4) hold for a strongly non-isothermal plasma. With $T_e \lesssim T_i$,

$$\varepsilon = \left(\frac{M}{m}\right)^{1/2} \varepsilon_0 = \pm \frac{\Omega_e' [n^2 - \varepsilon_{22}^{(0)}]^{1/2}}{[\varepsilon_{33}^{(0)} (n^2 - \varepsilon_{22}^{(0)}) - \varepsilon_{23}^{(0)2}]^{1/2}}, \qquad (14)$$

is obtained with neglection of the thermal motion of the electrons of the beam. ε^{o}_{ij} is the component of the tensor of the dielectric constant of the plasma without beam with $\omega = k_{\parallel}v_o$. An instability also occurs with $T_e \lesssim T_i$ if the plasma oscillations are weakly attenuated. With $kv'_i \ll |\omega - k_{\parallel}v_o| \ll kv'_e$ the thermal motion of the electrons in the beam has to be taken into account. (4) then has the solution $\omega = k_{\parallel}v_o + \varepsilon_o$, $|\varepsilon_o| \ll k_{\parallel}v_o|$ (15) where ε_o is obtained from (14). If $k_{\parallel}v_o$ lies near the eigenfrequency $kV_{\pm}$ of the magneto-acoustic wave in the nonisothermal plasma $\omega = kV_{\pm} + \varepsilon_o$, $|k(v_o\cos\theta - V_{\pm})| \ll |\varepsilon_o|$ (16) holds where ε_o is to be determined from (13). These formulas hold for sufficiently low temperatures of the beam $|\omega - k_{\parallel}v_o| \gg kv'_i$. With sufficiently small n'_o/n, $\omega = \omega_{\pm} + i\gamma_{\pm}$ holds with

$$\gamma_{\pm} = -\frac{\sqrt{\pi}\,\omega_{\pm}\sin^2\theta\,(\xi_e + \xi'_e + \xi'_i)}{4\zeta_{\pm}\,|\cos^2\theta - \zeta_{\pm}|\,(\zeta_{+} - \zeta_{-})}, \qquad \zeta_{\pm} = \left(\frac{V_{\pm}}{s}\right)^2.$$

Card 6/7

25206
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Interaction between charged ...

A beam with low density and high energy spread of the electrons and ions generally does not cause a magneto-acoustic wave in the plasma. There are 9 references. 7 Soviet-bloc and 2 non-Soviet-bloc. The two most recent references to English-language publications read as follows: D. Bohm, E. Gross. Phys.Rev., 75, 1851, 1864, 1949. I.B. Bernstein, R.M. Kulsrud. Phys.Fl., 3, 937, 1960.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences of the Ukrainskaya SSR)

SUBMITTED: January 27, 1961

Card 7/7

ACCESSION NR: AT4036038 S/2781/63/000/003/0003/0017

AUTHORS: Kitsenko, A. B.; Stepanov, K. N.

TITLE: Investigation of plasma oscillations in the quasihydrodynamic approximation

SOURCE: Konferentsiya po fizike plazmy* i problemam upravlyayemogo termoyadernogo sinteza. 3d, Kharkov, 1962. Fizika plazmy* i problemy* upravlyayemogo termoyadernogo sinteza (Plasma physics and problems of controlled thermonuclear synthesis); doklady* konferentsii, no. 3. Kiev, Izd-vo AN UkrSSR, 1963, 3-17

TOPIC TAGS: plasma oscillation, magnetohydrodynamics, ionized plasma, plasma ion oscillation, plasma wave reflection, terrestrial magnetism, solar corpuscular radiation, ionosphere

ABSTRACT: The longitudinal oscillations of a plasma with nonisotropic distribution function, and the excitation of magnetohydrody-

Card 1/3

ACCESSION NR: AT4036038

namic waves in interpenetrating plasma streams with nonisotropic particle velocity distribution functions, are considered on the basis of the quasihydrodynamic equations. It is confirmed on the basis of these equations that one-dimensional Langmuir oscillations of an electron gas can be regarded as adiabatic with an adiabatic exponent $\gamma = 3$. The effects of the ions on both high-frequency and low-frequency oscillations are considered. It is shown that anomalous dispersion occurs in both frequencies. In a plasma consisting of two species of ions, plasma resonance in the region of both high and low frequencies has the same distinguishing features, namely the limitation of the growth of the refractive index because of the presence of thermal motion of the plasma particles, and the appearance of a new branch of oscillations (plasma waves) with anomalous dispersion properties. An experimental investigation of the propagation of radio waves through a plasma at resonance makes it possible to determine several important characteristics of the plasma. The excitation of magnetohydrodynamic waves when streams

ACCESSION NR: AT4036038

of charged particles pass through a plasma is of particular interest in connection with the interaction between solar corpuscular streams in the upper ionosphere, for the plasma instability arising in the case of such a stream can lead to variations of the earth's magnetic field and to the appearance of ultralow frequency radiation. "In conclusion the authors are deeply grateful to A. I. Akhiyezer for interest in the work." Orig. art. has: 32 formulas.

ASSOCIATION: None

SUBMITTED: 00 DATE ACQ: 21May64 ENCL: 00

SUB CODE: ME, AA NR REF SOV: 016 OTHER: 004

Card 3/3

S/781/62/000/000/009/036

AUTHOR: Stepanov, K. N.

TITLE: Cyclotron resonance in a plasma

PERIODICAL: Fizika plazmy i problemy upravlyayemogo termoyadernogo sinteza; doklady I konferentsii po fizike plazmy i probleme upravlyayemykh termoyadernykh reaktsiy. Fiz.-tech. inst. AN Ukr. SSR. Kiev, Izd-vo AN Ukr. SSR, 1962, 45-52.

TEXT: The propagation of electromagnetic waves in an unbounded plasma is investigated on the basis of the kinetic theory for the case when the frequency of the wave is close to the cyclotron frequency of the electrons or of the ions (or is a multiple of these frequencies). The refractive indices and the attenuation coefficients are determined. The expresrions are found to be generalizations of those obtained previously by other workers. Account is taken of the thermal motion of the electrons. The limitations under which many of the simplifying assumptions are made are indicated.

There are 14 references, of which one is in English (J. E. Drummond, Phys. Rev. 110, 293 (1958).

Card 1/1

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B125/B102

Choosing the best variant of...

$$
\left.\begin{aligned}
E_z &= E_0 J_0(mr)\, e^{i(\omega t - k_3 z)};\\
E_r &= \frac{iE_0 k_3}{\frac{a+b}{a\varepsilon+b}\bar{k}_3^2 - \left(\frac{\omega}{c}\right)^2}\,\frac{m(a+b)}{(a+\varepsilon b)}\, J_1(mr)\, e^{i(\omega t - k_3 z)};\\
H_\varphi &= \frac{iE\frac{\omega}{c}m}{\frac{a+b}{a\varepsilon+b}\bar{k}_3^2 - \left(\frac{\omega}{c}\right)^2}\, J_1(mr)\, e^{i(\omega t - k_3 z)},
\end{aligned}\right\} \quad (12).
$$

The boundary conditions

$$
A|_{z=z_s-0} = A|_{z=z_s+0}; \quad \frac{1}{k^2}\frac{\partial A}{\partial z}\Big|_{z=z_s-0} = \frac{1}{k_1^2}\frac{\partial A}{\partial z}\Big|_{z=z_s+0}. \qquad (2)
$$

take account of the jump-like change in the properties of the medium at $z = z_s$. The formulas (12) agree with the known expressions for the components of an electromagnetic field in a waveguide containing an anisotropic dielectric, if the following condition is observed: The discs made of a homogeneous isotropic dielectric, that are fitted inside the waveguide, must be equivalent to an anisotropic dielectric having the effective ε components

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...ections corresponding to
- lens length. The stability
...g-wave accelerators reads

$$
\beta^2\lambda \ldots \frac{a_1+a_2}{a_2-a_1}, \quad l^2 = \frac{2\pi m\beta\lambda v_z^2}{eE\cos\varphi_s}(a_2-a_1). \qquad (25)
$$

Card 3/4

where l is the length of the lens. Proceeding from the equation of motion of a standing wave accelerator with drive tubes when there are six magnetic lenses per period, the condition obtained for the region of stable particle motion is given by

$$x = \frac{\beta\lambda}{4}\sqrt{\frac{4\pi eE\cos\varphi_s}{m\beta\lambda v_z^2}},$$

$$y = \frac{3\beta\lambda}{4}\sqrt{\frac{eH'}{mc^2\beta}}. \qquad (41).$$

There are 2 figures and 3 tables.

44886

S/861/62/000/000/017/022
B125/B108

AUTHORS: Akhiyezer, A. I., Faynberg, Ya. B., Selivanov, N. P., Stepanov, K. N., Pakhomov, V. I., Kovalev, O. V., Khizhnyak, N. A., ~~Gorbatenko~~, M. F., Bar'yakhtan, V. G., Shamshanov, A. A.

TITLE: Linear electron accelerators for high energies

SOURCE: Teoriya i raschet lineynykh uskoriteley, sbornik statey. Fiz.-tekhn. inst. AN USSR. Ed. by T. V. Kukoleva. Moscow, Gosatomizdat, 1962, 243 - 309

TEXT: This paper, finished in 1955, is a voluminous report on the most important results obtained at the Fiziko-tekhnicheskiy institut AN USSR (Physicotechnical Institute AS UkrSSR) between 1948 and 1955 as to the proper choice of an accelerating system and its optimum parameters as well as on the dynamics of the electrons inside the accelerator. One of the most efficient systems is the $\pi/2$ traveling wave type accelerator segmented by annular metal disks (designed by V. V. Vladimirskiy). The calculation of such a waveguide with the Walkinshow-Brillouin method (J. Appl. Phys., 20, 634 (1949)) is demonstrated. The radial motion of the electrons in a Bev-accelerator under the action of terrestrial magnetism and gravity should be

Card 1/2

Linear electron accelerator... S/861/62/000/000/017/022
B125/B108

compensated by the combined magnetic fields of rectilinear currents and a small number of electromagnets. In such a case, detectors are necessary indicating the displacement of the beam by the fields of the correcting magnets. Owing to the great length of linear accelerators, an additional radial focusing on the principal section is necessary. In the first section and in the injector this will be achieved by strong longitudinal magnetic fields. In the principal section radial focusing can be achieved by short magnetic lenses (diameter 50 cm) producing a longitudinal magnetic field of $\sim$1000 oe/cm, or by a system of four-pole lenses. Both systems can reduce the beam radius at the output of the accelerator to 0.5 cm. There are 1 figure and 18 tables.

Card 2/2

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B125/B108

Additional focusing of...

$$w'' + \frac{cE_0}{\varepsilon} w' + \frac{e^2 H^2}{4\varepsilon^2} w = 0. \quad (7)$$

with

$$u = w \exp\left\{ \frac{i}{2} e \int_{z_0}^{z} \frac{H(z)}{\varepsilon(z)} dz \right\} \quad (6)$$

and u = x + iy, where ε is the particle energy, and after having taken the random forces F_x and F_y into account, the deviation assumes the form

$$x = \frac{2L}{k_2 c E_0} \int_0^n \left\{ F_x(n') \cos \frac{k_1}{2} \ln \frac{\varepsilon(n')}{\varepsilon(n)} + F_y(n') \sin \frac{k_1}{2} \ln \frac{\varepsilon(n')}{\varepsilon(n)} \right\} \times$$
$$\times \sin \frac{k_2}{2} \ln \frac{\varepsilon(n)}{\varepsilon(n')} dn'. \quad (24)$$

where $k_1 = H_1/E_0$, $k_2 = H_2/E_0$, n is the number of the coil. The deviation in the y-direction is obtained by substituting $F_x \rightarrow F_y$ and $F_y \rightarrow -F_x$. Estimates as to the forces F_x and F_y arising from slight inclinations of the

Card 2/3

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B125/B108

Additional focusing of...

coils to the z-axis show that the correcting coils should be set with utmost precision. The method of additional focusing as discussed here is not particularly suitable. This paper was composed in 1956.

Card 3/3

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E032/E314

On the theory of ....

where T is the plasma temperature

$2\varepsilon''_{mn} = i\left[\varepsilon^{*}_{nm}(\underline{k}, \omega) - \varepsilon_{mn}(\underline{k}, \omega)\right]$ is the anti-hermitian part of the dielectric-constant tensor for the plasma $\varepsilon_{mn}(\underline{k}, \omega)$ and

$$\varphi(\underline{k}, \omega) = \frac{1}{(2\pi)^4} \iint e^{i(\omega t - kr)} \varphi(r, t) dr\, dt .$$

In the present paper the authors make use of Eq. (1) to investigate fluctuations in the electromagnetic field in an infinite plasma. A discussion is also given of the motion of the charged particles in plasma under the action of fluctuating electric fields. Formulae are derived for the correlation functions for the electric and magnetic fields in plasma located in a magnetic field. The asymptotic

Card 2/3

On the theory of S/141/62/005/001/006/024
E032/E314

behaviour of the correlation functions at large and small distances is investigated in the isotropic case. The paper is entirely theoretical and no numerical computations are reported. Acknowledgments to A.I. Akhiyezer, V.I. Kogan and V.P. Silin for discussions and advice. There is 1 figure.

SUBMITTED: April 29, 1961

Card 3/3

38085

S/040/62/026/003/008/020
D407/D301

24.6714
26.1410

AUTHORS: Stepanov, K.N., and Khomenyuk, V.V. (Khar'kov)

TITLE: On stability conditions for magnetohydrodynamic equilibrium configurations

PERIODICAL: Prikladnaya matematika i mekhanika, v. 26, no. 3, 1962, 466 - 470

TEXT: Stability of an ideally conducting fluid is defined, the definition differing from that given by the authors in an earlier work. Necessary and sufficient stability criteria are established, which are related to the well-known energy principle. With small displacements $\xi(r, t)$, of the fluid, the equations of motion are

$$\rho\ddot{\xi}_i = F_i(\xi) + f_i(\dot{\xi}) \qquad (i = 1, 2, 3) \tag{1.1}$$

where

$$\mathbf{F}(\xi) = \nabla(\xi\nabla p) + \gamma\nabla(p \operatorname{div} \xi) - \frac{1}{4\pi}\mathbf{H} \times \operatorname{rot}\operatorname{rot}(\xi \times \mathbf{H}) + \frac{1}{4\pi}\operatorname{rot}\mathbf{H} \times \operatorname{rot}(\xi \times \mathbf{H}) \tag{1.2}$$

$$f_i(\mathbf{v}) = \frac{\partial}{\partial x_k}\left[\eta\left(\frac{\partial v_i}{\partial x_k} + \frac{\partial v_k}{\partial x_i} - \frac{2}{3}\delta_{ik}\frac{\partial v_l}{\partial x_l}\right)\right] + \frac{\partial}{\partial x_i}\left(\zeta\frac{\partial v_l}{\partial x_l}\right) \tag{1.3}$$

Card 1/3

APPROVED FOR RELEASE: 08/25/2000 CIA-RDP86-00513R001653210005-8"

ρ, p and H being the equilibrium values of the density, pressure and magnetic field, γ - the adiabatic index, η and ζ - viscosity coefficients. The solutions of Eq. (1.1), satisfying the boundary - and initial conditions, are denoted by ξ. Expressions are obtained for the kinetic- (T) and potential energy (U). The notations

$$\rho_1\{\xi(\mathbf{r})\} = \int \xi^2 \, d\mathbf{r} + \alpha \sum_{k=1}^{3} \int \left(\frac{\partial \xi}{\partial x_k}\right)^2 d\mathbf{r}, \qquad \rho_2\{\dot{\xi}(\mathbf{r})\} = \int \rho \dot{\xi}^2 \, d\mathbf{r} \tag{2.1}$$

are introduced. By definition, the equilibrium is stable, if for any positive ε, it is possible to find positive δ, so that if

$$\rho_1\{\xi_0(\mathbf{r})\} < \delta_1, \qquad \rho_2\{\dot{\xi}_0(\mathbf{r})\} < \delta_2 \tag{2.2}$$

then for all $t \geqslant 0$

$$\rho_1\{\xi(t, \mathbf{r}, \xi_0(\mathbf{r}), \dot{\xi}_0(\mathbf{r}))\} < \varepsilon_1, \qquad \rho_2\{\dot{\xi}(t, \mathbf{r}, \xi_0(\mathbf{r}), \dot{\xi}_0(\mathbf{r}))\} < \varepsilon_2 \tag{2.3}$$

Instability is also defined, as well as the positive-definite functionals V and T. Theorem 3.1: (The necessary stability-condition): In order than an ideally conducting inviscid fluid be stable, it is necessary that U(ξ) ≥ 0 for all allowed ξ(r). Theorem 3.2: (The sufficient stability-condition): If U(ξ) is a positive-definite func-

On stability conditions for ...

S/040/62/026/003/008/020
D407/D301

tional in the metric $\rho_1(\xi)$, then the equilibrium of the fluid is stable. The theorem is proved. It is analogous to Lagrange's well-known theorem, whose generalization was proposed by A.A. Movchan (in the references) in stability investigations of elastic systems and continua. Further, the stability of viscous ideally conducting fluids is considered. Two theorems and a corollary give the stability (respectively instability-) conditions. The theorems are analogous to Kelvin's well-known theorems on the effect of dissipative forces on the equilibrium of material systems. The most important English-language reference reads as follows: A. Hare, The effect of viscosity on the stability of incompressible magnetohydrodynamic systems. Phil. Mag., 1959, v. 4, no. 48.

SUBMITTED: December 2, 1961

Card 3/3

S/057/62/032/003/006/019
B116/B102

24.6716

AUTHORS: Kitsenko, A. B., and Stepanov, K. N.

TITLE: Excitation of magnetosonic waves in dilute plasma by a charged particle flow

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 3, 1962, 303 - 307

TEXT: The excitation of "fast" and "slow" magnetosonic waves in dilute plasma by a charged particle flow of arbitrary density was studied. The following assumptions were made: The Alfvèn velocity is much greater than the sonic velocity, plasma and particle flow are dilute so that "near" collisions may be neglected, space charge and electric current of the particle flow are compensated in the state of equilibrium. The dispersion equation for magnetosonic waves

$$\frac{k^2c^2}{\omega^2} - \varepsilon_{22} - \frac{\varepsilon_{23}^2}{\varepsilon_{33}} = 0 \quad (1)$$

is written down, where ε_{ij} is the tensor of the dielectric constant (axis 3 runs parallel to the external magnetic field H_0, the wave vector $\vec{k}$ is in the 1-3 plane). (1) holds if $\omega \ll \omega_{Hi}$,

Card 1/5

$kv_i \ll \omega_{Hi}$, $kv_0 \ll \omega_{Hi}$, where ω_{Hi} and v_i = hydrogen frequency and mean thermal velocity of ions respectively, v_0 = beam velocity ($\vec{v}_0 \parallel \vec{H}_0$). If beam and plasma particles show Maxwellian velocity distribution, the components of ε_{ij} are:

$$\left.\begin{aligned}
\varepsilon_{11} &= 1 + \sum_\alpha \frac{\Omega_\alpha^2 (\omega - k_\parallel v_0)^2}{\omega_{H\alpha}^2 \omega^2},\\
\varepsilon_{22} &= \varepsilon_{11} + \sum_\alpha \frac{\Omega_\alpha^2 k^2 v_\alpha^2}{\omega_{H\alpha}^2 \omega^2} 2i\sqrt{\pi}\sin^2\theta\, z_\alpha w(z_\alpha),\\
\varepsilon_{33} &= 1 + \sum_\alpha \frac{\Omega_\alpha^2}{k_\parallel^2 v_\alpha^2}\left(1 + i\sqrt{\pi}\, z_\alpha w(z_\alpha)\right),\\
\varepsilon_{23} &= -\sum_\alpha \frac{\Omega_\alpha^2}{\omega_{H\alpha}\omega} \operatorname{tg}\theta \sqrt{\pi}\, z_\alpha w(z_\alpha),
\end{aligned}\right\} \qquad (2)$$

$$w(z_\alpha) = e^{-z_\alpha^2}\left(\pm 1 + \frac{2i}{\sqrt{\pi}}\int_0^{z_\alpha} e^{t^2}dt\right), \quad z_\alpha = \frac{\omega - k_\parallel v_0}{\sqrt{2}\, k_\parallel v_\alpha},$$

$$\Omega_\alpha^2 = \frac{4\pi e^2 n_{0\alpha}}{m_\alpha}, \quad v_\alpha^2 = \frac{T_\alpha}{m_\alpha}, \quad \omega_{H\alpha} = \frac{e_\alpha H_0}{m_\alpha c}, \quad k_\parallel = k\cos\theta,$$

X

θ is the angle between $\vec{k}$ and $\vec{H}_0$. First, the oscillations corresponding to the "fast" magnetosonic wave are investigated. It is assumed that $\frac{\omega}{k} \gg v_i$, v_i', $v_e\sqrt{m/M}$, $v_e'\sqrt{m/M}$, the indices e and i denote electrons and ions respectively, the primes refer to beam particles. The solution of (1) is $\omega = \omega_{\pm}$, where

$$\omega_{\pm} = k\frac{n_0' v_0 \cos\theta \pm \sqrt{n_0' n_0 (V_A^2 + V_A'^2 - v_0^2 \cos^2\theta)}}{n_0' + n_0}, \qquad (3)$$

$$V_A' = \frac{H_0}{\sqrt{4\pi n_0' M}}, \quad V_A = \frac{H_0}{\sqrt{4\pi n_0 M}}.$$

From (3) follows the instability condition $v_0^2 > V_A^2 + V_A'^2$. Consideration of the kinetic effects shows that instability may also occur at $v_0^2 < V_A^2 + V_A'^2$. In this case, $\omega = \omega_{\pm} + i\gamma_{\pm}$, $|\gamma_{\pm}| \ll |\omega_{\pm}|$. On the above assumptions, the dispersion equation for "slow" magnetosonic waves reads $\varepsilon_{33}(\omega,\vec{k}) = 0$ (6). For the case $|\omega - k_{\parallel} v_0| \gg k v_e'$, (6) gives

X

Card 3/5

$$\frac{\Omega_i^2}{\omega^2} + \frac{\Omega_i'^2}{(\omega - k_{\parallel} v_0)^2} = \frac{\Omega_i^2}{k_{\parallel}^2 s^2}(1 + i\sqrt{\pi} z_e), \qquad (7)$$

where $s = T_e/M$ is the sonic velocity, $z_e = \frac{\omega}{\sqrt{2}|k_{\parallel}| v_e}$ $(|z_e| \ll 1)$. If $z_e = 0$, the instability condition

$$v_0^2 < \frac{s^2}{n_0}\left[n_0^{1/3} + \left(n_0' \frac{M}{m}\right)^{1/3}\right]^3. \qquad (8)$$

is obtained. Explicit formulae for the increments γ can be obtained from (7) for some limiting cases only. For the case $kv_i' \ll |\omega - k_{\parallel} v_0| \ll kv_e'$, (6) gives

$$\frac{\Omega_i^2}{\omega^2} + \frac{\Omega_i'^2}{(\omega - k_{\parallel} v_0)^2} = \frac{\Omega_i^2}{k_{\parallel}^2 s^2}(1 + i\sqrt{\pi} z_i) + \frac{\Omega_i'^2}{k_{\parallel}^2 s'^2}(1 + i\sqrt{\pi} z_i'), \qquad (12)$$

Neglecting z_i and z_i', the instability condition

$$v_0^2 < \frac{n' s'^2 (n_0^{1/3} + n_0'^{1/3})^3}{n_0 s'^2 + n_0 s^2} \qquad (13).$$

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is obtained. The solution of (17) can be found explicitly in some special cases. For $|\omega - k_\parallel v_0| \ll k v_i'$, (7) gives $\omega = k_\parallel u + i\gamma$, where

$$\frac{1}{u^2} = \frac{1}{s^2} + \frac{n_0'}{n_0}\left(\frac{1}{s'^2} + \frac{1}{v_i'^2}\right),$$

$$\gamma \doteq -\sqrt{\frac{\pi}{8}}\,\omega_0 u^2 \left\{\sqrt{\frac{m}{M}}\frac{u}{s^3} + (u - v_0)\,\frac{n_0'}{n_0}\left(\sqrt{\frac{m}{M}}\frac{1}{s'^3} + \frac{1}{v_i'^3}\right)\right\}. \quad (18)$$

Then the instability condition is

$$v_0 - u > \frac{n_0 u s'^3 v_i'^3}{n_0' s^3 \left(\sqrt{\frac{M}{m}}\, s'^3 + v_i'^3\right)}. \quad (19)$$

A. I. Akhiyezer is thanked for advice. There are 7 references: 6 Soviet and 1 non-Soviet. The reference to the English-language publication reads as follows: I. B. Bernstein, R. M. Kulsrud. Phys. Fl., 3, 937, 1960.

SUBMITTED: January 31, 1961 (initially)
May 3, 1961 (after revision)

X

DOLGOPOLOV, V.V.; STEPANOV, K.N.

Heating of a plasma in the case of magnetoacoustic resonance. Zhur.tekh.fiz. 32 no.7:798-802 Jl '62. (MIRA 15:8)
(Plasma (Ionized gases)) (Magnetohydrodynamics)

PAKHOMOV, V.I.; STEPANOV, K.N.

Emission of low-frequency waves by ions and electrons in a magnetoactive plasma. Zhur.eksp.i teor.fiz. 43 no.6:2153-2165 D '62. (MIRA 16:1)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.
(Magnetohydrodynamics) (Plasma (Ionized gases)) (Waves)

ACCESSION NR: AT4036039 S/2781/63/000/003/0017/0036

AUTHORS: Pakhomov, V. I.; Stepanov, K. N.

TITLE: Radiation of low-frequency waves by ions and electrons in a magnetoactive plasma

SOURCE: Konferentsiya po fizike plazmy* i problemam upravlyayemogo termoyadernogo sinteza. 3d, Kharkov, 1962. Fizika plazmy* i problemy* upravlyayemogo termoyadernogo sinteza (Plasma physics and problems of controlled thermonuclear synthesis); doklady* konferentsii, no. 3, Kiev, Izd-vo AN UkrSSR, 1963, 17-36

TOPIC TAGS: magnetoactive plasma, plasma electromagnetic wave, plasma ion oscillation, plasma electron oscillation, Cerenkov radiation, bremsstrahlung, cyclotron radiation, plasmoid

ABSTRACT: Cyclotron radiation of ions having a velocity of the order of the average thermal velocity of the plasma ions is considered.

Card 1/3

ACCESSION NR: AT4036039

In addition, the Cerenkov radiation of electrons in the low-frequency region is considered. The intensity of radiation is determined with allowance for cyclotron absorption of the emitted waves by the plasma ions and the Cerenkov absorption by the plasma electrons. The radiating and absorbing ability of the plasma and the equilibrium intensity of radiation in these frequency regions are also determined. The expressions obtained for the intensity of radiation of an individual particle can be used also to estimate the intensity of radiation of charged-particle plasmoids moving through a plasma. If the plasma dimensions are smaller than the radiated wavelength, then the intensity of radiation becomes proportional to the square of the number of particles in the plasmoid (coherent radiation of the plasmoid). In the case of low frequencies, which is considered in this article, the wavelength is large and therefore the radiation can be coherent even at relatively large plasmoid dimensions. "In conclusion the authors are deeply grateful to A. I. Akhiyezer and V. F. Aleksin for a discussion of the work

ACCESSION NR: AT4036039

and for useful advice. Orig. art. has: 50 formulas.

ASSOCIATION: None

SUBMITTED: 00 DATE ACQ: 21May64 ENCL: 00

SUB CODE: ME, NP NR REF SOV: 011 OTHER: 000

Card 3/3

ACCESSION NR: AT4036043 S/2781/63/000/003/0064/0081

AUTHORS: Aleksin, V. F.; Stepanov, K. N.

TITLE: Spatial correlation of fluctuation electromagnetic fields in a plasma

SOURCE: Konferentsiya po fizike plazmy* i problemam upravlyayemogo termoyadernogo sinteza. 3d, Kharkov, 1962. Fizika plazmy* i problemy* upravlyayemogo termoyadernogo sinteza (Plasma physics and problems of controlled thermonuclear synthesis); doklady* konferentsii, no. 3. Kiev, Izd-vo AN UkrSSR, 1963, 64-81

TOPIC TAGS: plasma research, magnetoactive plasma, plasma electron oscillation, correlation statistics, plasma instability

ABSTRACT: Spatial correlation functions are obtained for electromagnetic fields in anisotropic gyrotropic media (magnetoactive plasma) in the cases when the effects due to the spatial dispersion of

Card 1/2

ACCESSION NR: AT4036043

the medium are small. It is shown that in the transparency region, when the damping is small, the correlation radius coincides with the attenuation length of the electromagnetic wave. General expressions are first derived for the correlation functions, after which spatial correlation functions are obtained for large distances. The correlation functions for high frequency (electron) oscillations are investigated, as are the spatial correlation functions in the low-frequency region. "In conclusion, the authors express deep gratitude to A. I. Akhiyezer and V. I. Pakhomov for a useful discussion and help with the work." Orig. art. has: 8 figures and 35 formulas.

ASSOCIATION: None

SUBMITTED: 00	DATE ACQ: 21May64	ENCL: 00
SUB CODE: ME	NR REF SOV: 007	OTHER: 000

Card 2/2

ACCESSION NR: AT4036046 S/2781/63/000/003/0096/0109

AUTHORS: Vasil'yev, M. P.; Grigor'yeva, L. I.; Dolgopolov, V. V.; Smerdov, B. I.; Stepanov, K. N.; Chechkin, V. V.

TITLE: Absorption of high-frequency energy by a plasma near ion cyclotron resonance. I.

SOURCE: Konferentsiya po fizike plazmy* i problemam upravlyayemogo termoyadernogo sinteza. 3d, Kharkov, 1962. Fizika plazmy* i problemy* upravlyayemogo termoyadernogo sinteza (Plasma physics and problems of controlled thermonuclear synthesis); doklady* konferentsii, no. 3. Kiev, Izd-vo AN UkrSSR, 1963, 96-109

TOPIC TAGS: cyclotron resonance phenomena, plasma heating, plasma thermal excitation, plasma magnetic field interaction, microwave plasma

ABSTRACT: Cyclotron absorption of electromagnetic waves excited by

Card 1/3

ACCESSION NR: AT4036046

current flowing in a coil surrounding a plasma cylinder are considered. The heating of a plasma by cyclotron excitation of strongly damped (ordinary) and weakly damped (extraordinary) waves is discussed. General expressions are derived for the power absorbed by the plasma (for the energy flux inside the plasma per unit length of the plasma cylinder). Since the general expressions are rather complicated, a few limiting cases are considered, namely when the wave frequency is close to the ion cyclotron frequency, high ion-gas temperature, long-wave oscillations, and short-wave oscillations. The case of a low density plasma is also considered. Other topics touched upon are the influence of collisions on the heating of the plasma, the excitation of weakly damped (extraordinary waves in a plasma cylinder, and the heating of a plasma consisting of a mixture of two species of ions (such as deuterium and tritium. Orig. art. has: 2 figures and 24 formulas.

ASSOCIATION: None

ALEKSIN, V.F.; STEPANOV, K.N.

Spatial correlation of fluctuational electromagnetic fields in plasma. Izv. vys. ucheb. zav.; radiofiz. 6 no.2:297-310 '63. (MIRA 16:6)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.
(Plasma(Ionized gases))
(Electromagnetic fields)

STEPANOV, K.N.

Absorption of electromagnetic waves in quasi-longitudinal propagation. Izv. vys. ucheb. zav.; radiofiz. 6 no.2:403-405 '63. (MIRA 16:6)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.
(Electromagnetic waves)

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IJP(C) Pz-4/Pab-4/Pi-4/Po-4 AT
ACCESSION NR: AP3004834 S/0141/63/006/003/0480/0487

82

AUTHOR: Aleksin, V. F.; Stepanov, K. N.

81

TITLE: Spatial correlation of fluctuating electromagnetic fields in plasma. 2.

21

SOURCE: IVUZ. Radiofizika, v. 6, no. 3, 1963, 480-487

TOPIC TAGS: electromagnetic field, plasma, fluctuating field, magneto-active plasma, plasma resonance, gyroresonance

ABSTRACT: This is a continuation of these authors' work (Izv. vy*ssh. uch. zav., Radiofizika, 6, 297, 1963). Correlation functions for Fourier components (with respect to time) are found for fluctuating electric and magnetic fields in a magneto-active plasma near plasma resonance, electron gyroresonance and ion gyroresonance. "In conclusion, the authors feel deeply indebted to A. I. Akhiezer for discussing their work." Orig. art. has: 2 figures and 14 formulas.

ASSN: Physicotechnical Institute, AN UkrSSR.

Card 1/1

KRASOVITSKIY, V.B.; STEPANOV, K.N.

Excitation of electromagnetic waves in a plasma by an ion beam. Izv. vys. ucheb. zav.; radiofiz. 6 no.5:1056-1059 '63. (MIRA 16:12)

1. Khar'kovskiy gosudarstvennyy universitet.

PAKHOMOV, V.I.; STEPANOV, K.N.

Radiation of an electron moving along a spiral in a magnetoactive plasma. Part 2. Zhur.tekh.fiz. 33 no.1:43-50 Ja '63.
(MIRA 16:2)

1. Fiziko-tekhnicheskiy institut AN UkrSSR, Kahr'kov.
(Plasma (Ionized gases)) (Electrons) (Radiation)

S/057/63/033/004/012/021
B163/B234

AUTHORS: Pakhomov, V. I., and Stepanov, K. N.

TITLE: On the radiation of an electron moving along a spiral in a magnetoactive plasma III

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 33, no. 4, 1963, 437 - 443

TEXT: The magnetic bremsstrahlung and Cherenkov radiation of an electron is studied theoretically. Expressions derived earlier by Pakhomov, Aleksin, and Stepanov, and by Eydman, for the radiation intensity and the absorption of radiation by the plasma become inapplicable if the frequency $\omega_s = s\omega_H + k_{\parallel}v_{\parallel}(s = 1,2,3...)$ of the emitted radiation approaches one of the fundamental frequencies ω_+ or ω_-, respectively, of the longitudinal plasma oscillations in the magnetic field, because in this case the index of refraction of the ordinary or extraordinary wave, respectively, becomes infinite. If the thermal motion of the plasma electrons is taken into account, the index of refraction remains finite even for $\omega \approx \omega_{\pm}$. It

Card 1/2

On the radiation of an electron...

S/057/63/033/004/012/021
B163/B234

is shown that in the case of double resonance the intensity of the magnetic bremsstrahlung of electrons whose velocity is of the order of the mean thermal velocity v_r of the plasma electrons, is increased by the factor $(c/v_r)^{s+1}$ (s = 3,4...) as compared with the radiation intensity in the vacuum, where c is the velocity of light. For the Cherenkov radiation (s = 0) of "fast" particles it is found that the total radiation losses of a nonrelativistic particle moving along a spiral are finite. There are 2 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN USSR, Kharkov (Physico-technical Institute of the AS UkrSSR, Kharkov)

SUBMITTED: April 4, 1962

Card 2/2

DOLGOPOLOV, V.V.; STEPANOV, K.N.

Absorption of the energy of a high-frequency field by a plasma in the case of multiple ionic gyroresonance. Zhur. tekh. fiz. 33 no.10:1196-1199 O '63. (MIRA 16:11)

LOMINADZE, D.G.; STEPANOV, K.N.

Induction of low-frequency oscillations in a magnetoactive plasma by a flux of charged particles. Zhur. tekh. fiz. 33 no.11:1311-1314 N '63. (MIRA 16:12)

1. Institut fiziki AN Gruzinskoy SSR i Fiziko-tekhnicheskiy institut AN UkrSSR.

STEPANOV, K.N.

Theory of high-frequency heating of a plasma. Zhur. eksp. i teor. fiz. 45 no.4:1196-1201 O '63. (MIRA 16:11)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.

DOLGOPOLOV, V.V.; YERMAKOV, A.I.; NAZAROV, N.I.; STEPANOV, K.N.; TOLOK, V.T.

Experimental observation of Landau damping in a plasma. Zhur. eksp. i teor. fiz. 45 no.4:1260-1261 O '63. (MIRA 16:11)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.

L 1593-66 EWT(1)/EPF(n)-2/EWG(m)/EPA(w)-2 IJP(c) AT

AM5007590 BOOK EXPLOITATION UR/ 533.9 76 B+1

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Akhiyezer, A. I.; Akhiyezer, I. A.; Polovin, R. V.; Sitenko, A. G.; Stepanov, K. N.

21,44,55

Collective oscillations in plasma (Kollektivnyye kolebaniya v plazme) Moscow, Atomizdat, 1964. 0162 p. illus., biblio. 3,700 copies printed.

TOPIC TAGS: plasma physics, plasma oscillation, charged particle, magnetic field plasma stability, ,particle distribution, particle scatter

PURPOSE AND COVERAGE: This book is a presentation of the theory of linear oscillations in "Collisiouless" plasma in which paired collisious do not exert significant influence on its oscillations properties. Three basic problems are presented in the book: natural oscillations spectra, stability and instability of various particle distributions, and fluctuations in homogeneous plasma. The book will be of interest to scientists working in the fields of physical and technological problems such as: diffusion of radio waves in the ionosphere and other plasmas, stellar radioemission, microradiowave amplification and generation with the aid of plasma, acceleration of charged particles in plasma, relaxation in plasma, plasma diagnosis, etc.

Card 1/2

L 1593-66
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TABLE OF CONTENTS (abridged):

Foreword - - 5
Ch. I. Spectra of natural oscillations of free plasma - - 7
Ch. II. Plasma oscillation spectra in a magnetic field - - 27
Ch. III. Stable and unstable particle distributions in plasma - - 62
Ch. IV. Fluctuations in plasma - - 97
Ch. V. Wave scattering and transformation and charged particle scattering in plasma - - 120
Bibliography - - 157

SUB CODE: ME, NP

SUBMITTED: 26Sep64

NR REF SOV: 100

OTHER: 045

Card 2/2

L 51316-65 EWP(m)/EPR/EWG(v)/EPA(w)-2/EWT(1)/T-2/EPA(sp)-3/EWA(m)-2
Pd-1/Pe-5/Pi-4/Ps-4/Pab-10 IJP(c)

ACCESSION NR: AP5008494 S/0207/64/000/006/0023/0030

AUTHOR: Sizonenko, V.L. (Khar'kov); Stepanov, K. N. (Khar'kov)

66
43

TITLE: The stability of tangential discontinuities in magnetohydrodynamics

SOURCE: Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki, no. 6, 1964, 23-30

TOPIC TAGS: tangential discontinuity, stability, ideally conducting fluid, compressible fluid, strong magnetic field, stability region, sound velocity, magnetohydrodynamics

ABSTRACT: The authors investigate the stability of the tangential discontinuity of an ideally conducting, compressible fluid in a strong magnetic field when the Alfven velocity along both sides of the surface of discontinuity $V_{a1,2}$ is considerably greater than the velocity of sound. It is shown that the tangential discontinuity is unstable if the magnetic field does not change in direction (or rotates by 180°) in passing through the surface of discontinuity and if the velocity jump of the fluid v is not collinear to the magnetic field. If the velocity v is collinear to the magnetic field, or if the angle between the magnetic fields along both sides of the surface of discontinuity is not close to zero, then the

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ACCESSION NR: AP5008494

tangential discontinuity is stable when $v < v^*$, and unstable when $v > v^*$, where v^* is the order of the Alfven velocity. The boundary of the region of stability $v = v^*$ is also found for a number of limiting cases. It is shown in the general case that a strong magnetic field stabilizes the tangential discontinuity when $0 < v \ll V_{a1,2}$. However, the exact determination of the upper boundary of the stability region is, apparently, possible only through numerical calculations. Orig. art. has: 7 figures and 26 formulas.

ASSOCIATION: none

SUBMITTED: 06Mar64 ENCL: 00 SUB CODE: ME, EM

NO REF SOV: 003 OTHER: 001

BJB

Card 2/2

ACCESSION NR: AP4024470 S/0141/64/007/001/0083/0093

AUTHORS: Krasovitskiy, V. B.; Stepanov, K. N.

TITLE: Passage of ion beams through a plasma

SOURCE: IVUZ. Radiofizika, v. 7, no. 1, 1964, 83-93

TOPIC TAGS: plasma, electromagnetic waves in plasma, ion beam in plasma, electron gyrofrequency, ion gyrofrequency, thermal velocity, dielectric tensor, longitudinal propagation, quasilongitudinal propagation, quasitransverse propagation, injection angle

ABSTRACT: This is a continuation of earlier work (Izv. VUZov, Radiofizika, v. 6, 1056, 1963) on the excitation of electromagnetic waves in a plasma by an ion beam of low density and large thermal velocity scatter, in the range between the electron and ion gyrofrequencies, with the ions moving parallel to the magnetic field. In the present work the ions are assumed injected at a large angle to

ACCESSION NR: AP4024470

the field, so that both ion beam velocity components are much larger than the thermal velocity. The dielectric tensor is evaluated for this case, and waves excited by quasi-longitudinal, longitudinal, and quasi-transverse propagation are analyzed. It is found that the growth increment for oblique injection is appreciably larger than for injection parallel to the magnetic field. As a numerical example it is shown that a plasma of density 10^{-6} cm^{-3} propagating through the upper atmosphere with parallel and perpendicular velocity components each equal to 7×10^8 cm/sec (as against a thermal velocity of 10^6 cm/sec) has a growth increment $\gamma \sim 0.2$ sec^{-1}, covers $\sim 3.5 \times 10^4$ km during a time on the order of $1/\gamma$, and radiates at a frequency $\sim 3 \times 10^3$ sec^{-1}. "In conclusion, the authors are deeply grateful to A. I. Akhiyezer and V. F. Aleksin for a discussion of the work and for useful advice." Orig. art. has: 1 figure and 33 formulas.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN UkrSSR (Physicotech-

ACCESSION NR: AP4024470

nical Institute, AN UkrSSR)

SUBMITTED: 14Jan63 DATE ACQ: 15Apr64 ENCL: 00

SUB CODE: PH NO REF SOV: 007 OTHER: 001

Card 3/3

ACCESSION NR: AP4040297 S/0057/64/034/006/0974/0983

AUTHOR: Vasil'yev, M. P.; Grigor'yeva, L. I.; Dolgopolov, V. V.; Smerdov, B. I.; Stepanov, K. N.; Chechkin, V. V.

TITLE: On the absorption of high frequency energy by a plasma at frequencies near ion cyclotron resonance. 1.

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.6, 1964, 974-983

TOPIC TAGS: plasma, plasma heating, cyclotron resonance phenomena, electromagnetic wave absorption

ABSTRACT: The absorption of electromagnetic waves by a plasma at frequencies near the ion cyclotron resonance, discussed by T.H.Stix (Phys.Rev.106,1146,1957) as a means for heating a plasma, is treated theoretically for a cylindrical plasma filament of constant density. The high frequency electromagnetic field is assumed to be produced by traveling waves in a helical winding surrounding the plasma filament. The slight modifications required when the excitation is by standing waves in the helix are derived in an appendix. Damping both by ion collision and by cyclotron absorption, the process inverse to cyclotron radiation (magnetic bremsstrahlung),

ACCESSION NR: AP4040297

are included in the treatment. A general expression for the energy flux is derived, and this is simplified and discussed in more detail for a number of limiting cases. The curve of absorption versus frequency is asymmetric, and the maximum absorption occurs at a frequency somewhat less than the Larmor frequency. The absorption of the slightly damped extraordinary wave is discussed. This can become important when the skin depth is too small to permit adequate penetration of the ordinary wave. The resonance, however, is very sharp, and it might be difficult to maintain adequate frequency control. Excitation of a plasma containing two ion species at the Larmor frequency of one of them produces a relative motion of the two ion species of the type discussed by S.J.Buchsbaum (Phys.Fl.3,418,1960) in connection with the low frequency hybrid resonance. "The authors express their deep gratitude to A.I. Akhiyezer and K.D.Sinel'nikov for valuable advice and discussions of the work." Orig.art.has: 40 formulas and 2 figures.

ASSOCIATION: none

SUBMITTED: 15Mar63 DATE ACQ: 19Jun64 ENCL: 00

SUB CODE: ME NR REF SOV: 008 OTHER: 004

Card 2/2

S/0057/64/034/006/0984/0993

ACCESSION NR: AP4040298

AUTHOR: Vasil'yev, M.P.; Grigor'yeva, L.I.; Dolgopolov, V.V.; Smerdov, B.I.; Stepanov, K.N.; Chechkin, V.V.

TITLE: Experimental investigation of the absorption of high frequency energy by a plasma at frequencies near cyclotron resonance. 2.

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.6, 1964, 984-993

TOPIC TAGS: plasma, plasma heating, cyclotron resonance phenomena, electromagnetic wave absorption, hydrogen plasma

ABSTRACT: The absorption of high frequency energy by a hydrogen plasma at frequencies near the ion cyclotron resonance was investigated experimentally. The plasma was formed by discharge of a 6 microfarad capacitor, charged to 3 to 5 kV, between two cathodes at the ends of an 88 cm long 6 cm diameter discharge tube and an annular anode located 6 cm from one of the cathodes. The period of this system was 35 microsec. A longitudinal magnetic field up to 6.5 kOe was produced by discharge of a 0.006 farad capacitor bank through an appropriate solenoid. The period was 18 millisec, and the field could be considered constant during the 500 microsec observa-

ACCESSION NR: AP4040298

tion time. The magnetic field strength increased at the ends of the discharge tube, thus providing magnetic mirrors for confinement of the plasma. The high frequency electromagnetic field was produced by currents in a 7 cm diameter 7/8 cm pitch helix, coaxial with the discharge tube and loaded every 7 cm by a 450 micromicrofarad capacitor. This line was coupled to a pulsed self-excited oscillator operating at 7.5 megacycles/sec. The density of the plasma was determined with an 8.1 mm microwave interferometer. The electron temperature was determined from the intensity ratio of HeI 4921 to HeI 4713, 5% He having been added to the hydrogen to provide these lines. The ion temperature was determined from the Doppler broadening of H_β. The power absorbed by the plasma was determined by measuring the power delivered by the oscillator to the helical line. The maximum power absorbed by the plasma in these experiments was 18 kW. During the flow of the discharge current, the ion temperature rose to several eV and the electron temperature to several tens of eV. The temperatures fell rapidly after the discharge ceased, and the electron temperature was less than 1 eV after 60 microsec. During about the first 100 microsec, when the plasma density was greater than 5×10^{13} cm^{-3}, a non-resonant absorption of high frequency energy was observed, the nature of which is not understood. The expected resonance absorption occurred after the density had fallen below 5×10^{13} cm^{-3}. The

Card 2/3

resonance absorption was investigated and compared with the theory published by the present authors in the preceding paper (ZhTF 34,974,1964 [see Abstract AP4040297]). The conditions of the plasma were such that the absorption was entirely by collision The relation between plasma density and the shift of the absorption peak from the Larmor frequency was in good agreement with the theory. The width of the absorption band varied more rapidly with plasma density than the theory predicts. The energy balance in the plasma is discussed. The energy absorbed by the ions was rapidly transferred to the electrons and lost. It is concluded that significant heating can be achieved with the present method only by increasing the power or providing supplementary heating by the electrons. "The authors express their gratitude to V.T. Tolok, V.I.Konenko, O.S.Pavlichenko, V.A.Suprunenko and V.T.Pilipenko for assisting in the work and discussing the results." Orig.art.has: 5 formulas, 8 figures and 1 table.

ASSOCIATION: none

SUBMITTED: 08May63 DATE ACQ: 19Jun64 ENCL: 00

SUB CODE: ME NR REF SOV: 007 OTHER: 003

Card 3/3

ACCESSION NR: AP4040303 S/0057/64/034/006/1013/1019

AUTHOR: Krasovitskiy, V.B.; Stepanov, K.N.

TITLE: Excitation of longitudinal oscillations in a plasma with anisotropic ion velocity distribution

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.6, 1964, 1013-1019

TOPIC TAGS: plasma, plasma stability, plasma oscillation, plasma instability, magnetic mirror, plasma confinement

ABSTRACT: The stability of a plasma with a highly anisotropic ion velocity distribution with respect to the development of longitudinal oscillations in a magnetic field is discussed theoretically because of its importance for the confinement of plasma in adiabatic magnetic mirror systems such as the DCX and OGRA devices. The distribution of the difference between the ion velocity and a constant drift velocity perpendicular to the magnetic field is assumed to be Maxwellian. The drift velocity is assumed to be large compared with the thermal velocities; the ion velocity distribution function accordingly approximates a delta function. The electron velocity distribution is assumed to be Maxwellian. The dispersion equation for wave-

ACCESSION NR: AP4040303

lengths considerably longer than the electron Larmor radius is written without derivation or reference. This dispersion equation is simplified, first for low density and wavelengths of the order of the ion Larmor radius, and then for wavelengths short compared with the ion Larmor radius. The simplified dispersion equations are discussed in detail, and expressions are given for the logarithmic increment (imaginary part of the complex frequency) for each of the instabilities found. The dispersion equation for low densities and long wavelengths is discussed separately for the three cases that both the ions and the electrons, only the ions, and only the electrons, respectively, are cold. When both the ions and electrons are cold the plasma is stable provided the density is not too great (electron Langmuir frequency less than the ion Larmor frequency), but instabilities appear as the density increases, first at the ion Larmor frequency, and then at its successive harmonics. The plasma is found to be unstable even when the ions are hot, in contradiction with the conclusion of V.I.Pistunovich (Atomnaya energiya 14,72,1963) that heating the ions stabilizes the plasma. The discrepancy is ascribed to Pistunovich's use of an unsuitable distribution function. Orig.art.has: 26 formulas and 1 figure.

Card 2/2

ACCESSION NR: AP4040303

ASSOCIATION: none

SUBMITTED: 18Mar63 DATE ACQ: 19Jun64 ENCL: 00

SUB CODE: ME NR REF SOV: 004 OTHER: 002

Card 3/3

S/0057/64/034/007/1210/1223

ACCESSION NR: AP4041996

AUTHOR: Aleksin, V.F.; Stepanov, K.N.

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.7, 1964, 1210-1223

TOPIC TAGS: plasma, electromagnetic wave generation, plasma electromagnetic wave, cyclotron resonance

ABSTRACT: A detailed linear theory is gieven of the radiation of electromagnetic waves into an infinite uniform magnetized plasma by the following two current distributions:

$$\mathbf{j}(\mathbf{r},\, t)=j_0\cos(k_\parallel z-\omega t)\,\delta(r_\perp-a)\frac{[\mathbf{hr}]}{r_\perp} \quad \text{and} \quad \mathbf{j}=\frac{j_0}{\pi a^2}\cos(k_\parallel z-\omega t)\,\mathbf{h}$$

($r_\perp < a$), $\mathbf{j} = 0$ ($r_\perp > a$). Here $\mathbf{j}$ is the current density, $r_\perp$ and z are the radial and axial cylindrical coordinates, t is the time, $\mathbf{r}$ is the position vector, $\mathbf{h}$ is a unit vector in the direction of the applied magnetizing field, and $k_\parallel$, ω, j_0, and a are constants. The dielectric tensor for a magnetized plasma is taken from earlier work of the authors and an associate (V.I.Pakhomov, V.F.Aleksin and K.N.Stepanov, ZhTF 31,1170,1961), and with its aid general expressions are derived for the electric fields produced and the power radiated by the two current distributions. These

Card 1/3

...tron and ion
...) and near the two hybrid ... which the high frequency hybrid
... excitation ... electron Larmor frequency hybrid
... on when $\omega k_\parallel$ is small. The ... of longitudinal oscillations ... is discussed se-
... particles are taken into account in the discussions ... thermal motions and collisions of the axial cur-
when they become important. "In conclusion, the authors express their deep grati-
tude to A.I.Akhiezer for suggesting the problem and for his interest in the work."
Orig. art. has: 83 formulas, 2 figures and 1 table. [illegible] resonances

Card 2/3

ACCESSION NR: AP4041996

ASSOCIATION: none

SUBMITTED: 13Dec62

ENCL: 00

SUB CODE: ME,EM

NR REF SOV: 009

OTHER: 003

Card 3/3

ACCESSION NR: AP4041998 S/0057/64/034/007/1231/1236

AUTHOR: Vasil'yev, M.P.; Grigor'yeva, L.I.; Dolgopolov, V.V.; Smerdov, B.I.; Stepanov, K.N.; Chechkin, V.V.

TITLE: On the cyclotron resonance in a nonuniform plasma cylinder

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.7, 1964, 1231-1236

TOPIC TAGS: plasma, nonuniform plasma, cyclotron resonance, plasma heating

ABSTRACT: The heating of a cylindrical plasma by resonance absorption at the ion Larmor frequency (T.H.Stix,Phys.Fl.1,308,1958) is discussed theoretically for the case when the plasma temperature and density may vary with distance from the axis. It is assumed that the external high frequency field is produced by travelling waves of current on a cylindrical surface coaxial with the plasma cylinder, and that the magnetic pressure in the plasma is large compared with the kinetic pressure. The thermal motion of the particles tranvservely to the magnetic field is neglected. Expressions for the power absorbed are derived by a perturbation method for the four cases when the plasma is either so hot that the effect of collisions may be neglected or so cold that the collisions are of overwhelming importance, and either the

Card 1/2

ACCESSION NR: AP4041998

density of the plasma is low or the radius of the plasma cylinder is small compared with the wavelength. The absorption curve of a low density plasma is shown to be symmetric about the cyclotron frequency, but the maximum absorption of a dense plasma filament is found to occur at a lower frequency. The theoretical absorption curves for a cold plasma are reported to be in good agreement with recent experimental data of the present authors (ZhTF 34, No. 6, 1964). If the density of a cold plasma filament is independent of distance from the axis, the absorption curve is symmetric about the displaced maximum. If, however, the plasma filament is not uniform, the absorption curve becomes asymmetric. The asymmetry of the absorption curves observed earlier by most of the present authors (V.V.Chechkin, M.P.Vasil'yev, L.I.Grigor'yeva and B.I.Smerdov, ZhTF 31, 1033, 1961) is ascribed to the nonuniform density of the plasma filaments. "In conclusion, the authors thank A.I.Akhezer for his interest in the work and for discussing the results." Orig. art. has: 36 formulas a 2 figures.

ASSOCIATION: none

SUBMITTED: 09May62 ENCL: 00

SUB CODE: ME NR REF SOV: 004 OTHER: 001

L 10745-65 EWT(l)/EWG(k)/EPA(sp)-2/EPA(w)-2/EEC(t)/T/EEC(b)-2/EWA(m)-2 Po-4/Pi-4/Pz-6/Pab-24 IJP(c)/SSD/AFETR/ESD(t)/ASD(p)-3/RAEM(a)/ESD(gs) AT

ACCESSION NR: AP4046343 S/0057/64/034/010/1823/1834

AUTHOR: Lominadze, D.G.; Stepanov, K.N.

B

TITLE: Excitation of low frequency longitudinal oscillations in a plasma in a magnetic field

21

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.10, 1964, 1823-1834

TOPIC TAGS: magnetized plasma, plasma wave, plasma beam interaction, plasma oscillation generation.

ABSTRACT: The authors discuss the low frequency longitudinal oscillations of a plasma in a magnetic field, and in particular their excitation by drifting electrons and by streams of ions and electrons moving parallel to the applied field. The treatment is based on a dispersion equation published by K.N.Stepanov (ZhETF 35,1155, 1958). The solutions of the dispersion equation are discussed in detail before excitation of the waves is considered. Long and short wavelength oscillations are distinguished; the wavelength of the former greatly exceeds the electron Larmor radius, and that of the latter is of the order of the ion Larmor radius. The long wavelength oscillations are discussed in the case when the electron temperature greatly exceeds

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ACCESSION NR: AP4046343

the ion temperature and the phase velocity in the direction of the applied field is much greater than the ion thermal velocity and much less than the electron thermal velocity. The short wavelength oscillations are discussed for all values of the ratio of the ion to the electron temperature, but for propagation nearly normally to the applied field so that the phase velocity in the direction of the field is much less than the electron thermal velocity. These oscillations include those at frequencies near the ion Larmor frequency, mentioned by W.E.Drummond and M.N.Rosenbluth (Phys.Fl.5,1507,1962). Oscillations of all the types discussed can be excited by the drift of electrons due to an external electric field or by streams of ions and electrons moving parallel to the magnetic field, provided the drift velocity or the stream velocity exceeds the phase velocity of the waves. The excitation of the waves by this mechanism is discussed in detail, and formulas for the logarithmic increments are derived for a variety of special conditions as regards the density, temperature and velocity of the stream. "In conclusion, the authors express their deep gratitude to A.I.Akhiyezer for suggesting the problem, for his interest in the work and for advice." Orig.art.has: 117 formulas, 3 figures and 1 table.

L 10745-65
ACCESSION NR: AP4046343

0

ASSOCIATION: none

SUBMITTED: 09Apr64

ENCL: 00

SUB CODE: ME,EM

NR REF SOV: 004

OTHER: 001

3/3

L 23815-65 EWT(1)/EWG(k)/EPA(sp)-2/EPA(w)-2/EEC(t)/T/EEC(b)-2/EWA(m)-2 Pz-6/Po-4/Pab-10/Pi-4 IJP(c) AT

ACCESSION NR: AP 5000838 S/0057/64/034/012/2146/2152

AUTHOR: Stepanov, K.N

TITLE: Concerning the instability of ionic cyclotron waves in plasma

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.12, 1964, 2146-2152

TOPIC TAGS: plasma waves, plasma instability, plasma oscillation

ABSTRACT: In the present paper there is considered from the theoretical standpoint the excitation of longitudinal oscillations in a plasma in the field of an ionic cyclotron wave. If, under the action of the cyclotron-wave electric field, the plasma electrons and ions acquire a sufficiently high relative velocity, there may develop in the plasma a "bunch" instability, associated with excitation of longitudinal oscillations. It is shown that if the relative velocity u of the plasma electrons and ions is appreciably greater than the electron thermal velocity v_e, there should occur excitation of both modes of the high-frequency longitudinal oscillations of the plasma in a magnetic field. On the other hand, when $v_i \ll u \leq v_e$ (v_i is the thermal velocity of the ions), there is excited only the lower frequency mode and the oscillations propagate virtually normal to the magnetic field. After

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ACCESSION NR: AP5000838

a general analysis, the author considers the case of excitation of oscillations of a plasma consisting primarily of a mixture of two kinds of ions and the case of excitation of oscillations in the presence of collisions (previously neglected on the assumption of high-temperature plasma). The instability increments are evaluated for the different cases and it is found that the increment in all the examined cases is substantially greater than the ionic cyclotron frequency; thus, under the postulated conditions the plasma is inherently unstable. The last is illustrated briefly by a numerical example. Orig.art.has: 24 formulas.

ASSOCIATION: none

SUBMITTED: 02Jan64 ENCL: 00 SUB CODE: ME

NR REF SOV: 010 OTHER: 002

STEPANOV, K.N. (Moskva)

Case of thrombosis of a choroid plexus aneurysm of the third ventricle complicated by acute hydrocephalus. Zhur. nevr. i psikh. vol. 64 no. 5:661-662 '64. (MIRA 17:7)

L [illegible] EWT(1)/EWT([illegible]

ACC NR: AT6031153 SOURCE CODE: UR/3137/65/000/244/0003/0018

AUTHOR: Bar'yakhtar, V. G.; Savchenko, M. A.; Stepanov, K. N. 62

ORG: none B+1

TITLE: Interaction of plasma and spin waves in ferromagnetic semiconductors and metals

SOURCE: AN UkrSSR. Fiziko-tekhnicheskiy institut. Doklady, no. 244/T-027, 1965. O vzaimodeystvii plazmennykh i spinovykh voln v ferromagnitnykh poluprovodnikakh i metallakh, 3-18

TOPIC TAGS: semiconductor, spin wave, ferromagnetic semiconductor, plasma wave, semiconductor plasma

ABSTRACT: A study is conducted of coupled spin, plasma, and electromagnetic waves in ferromagnetic semiconductors and metals at arbitrary wave propagation directions. The refractive indices and transmission regions of these ferromagnetic semiconductors and metals are determined. Orig. art. has: 41 formulas. [Authors' abstract] [SP]

SUB CODE: 20/ SUBM DATE: none/ ORIG REF: 006/ OTH REF: 002

metal physics 18

1/1